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Shanmugam et al.

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(45) **Date of Patent: Oct. 11, 2016**

(54) **CONFIGURATION-BASED PROCESSING OF REQUESTS BY CONDITIONAL EXECUTION OF SOFTWARE CODE TO RENDER REGIONS IN A DISPLAY**

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(73) Assignee: **Oracle International Corporation**, Redwood Shores, CA (US)

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(65) **Prior Publication Data**

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Related U.S. Application Data

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(51) **Int. Cl.**

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G06F 9/00	(2006.01)
H04L 29/08	(2006.01)
H04L 29/06	(2006.01)
G06F 17/30	(2006.01)

(52) **U.S. Cl.**

CPC . ***G06F 8/70*** (2013.01); ***G06F 9/00*** (2013.01); ***G06F 17/30595*** (2013.01); ***H04L 67/36*** (2013.01); ***H04L 67/42*** (2013.01)

(58) **Field of Classification Search**

None

See application file for complete search history.

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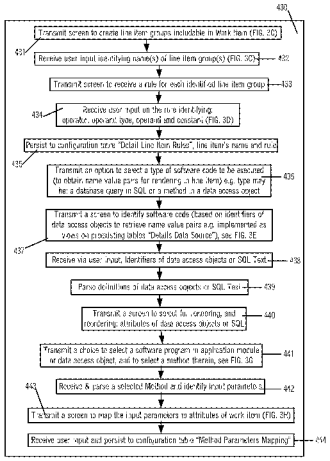
(57) **ABSTRACT**

Server(s) prepare requests to obtain user input indicative of at least one of approval or disapproval by conditionally including therein one or more regions based on rules. The rules are configurable, and each rule is associated with an identifier of a software code. On receipt of a message identifying a request, rules corresponding to regions includable in the request are evaluated to identify regions to be rendered. For a to-be-rendered region a software code identified in a rule action pair is executed to obtain one or more rows, each row including multiple name value pairs. The server(s) prepare content of the request, by including each name value pair in a single line among multiple lines for a row, the multiple lines being sequenced relative to one another in a specific sequence to be displayed by a mobile device, the specific sequence being configurable.

20 Claims, 34 Drawing Sheets



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Developing Workflow Engine for Mobile Devices, pp. 2, believed to be published on or prior to Jan. 29, 2014 http://ieeexplore.ieee.org/xpl/articleDetails.jsp?tp=%arnumber=4384000&matchBoolean%3Dtrue%26pageNumber%3D3%26searchField%3DSearch_All%26queryText%3D%28%28%28workflow%29+OR+worklist%29+AND+mobile%29.

Sybase Mobile Workflow for SAP Business Suite, p. 1, believed to be published on or prior to Jan. 27, 2014, at http://www.sybase.in/products/mobileenterprise/mobileworkflowforsapbusinesssuite.

* cited by examiner

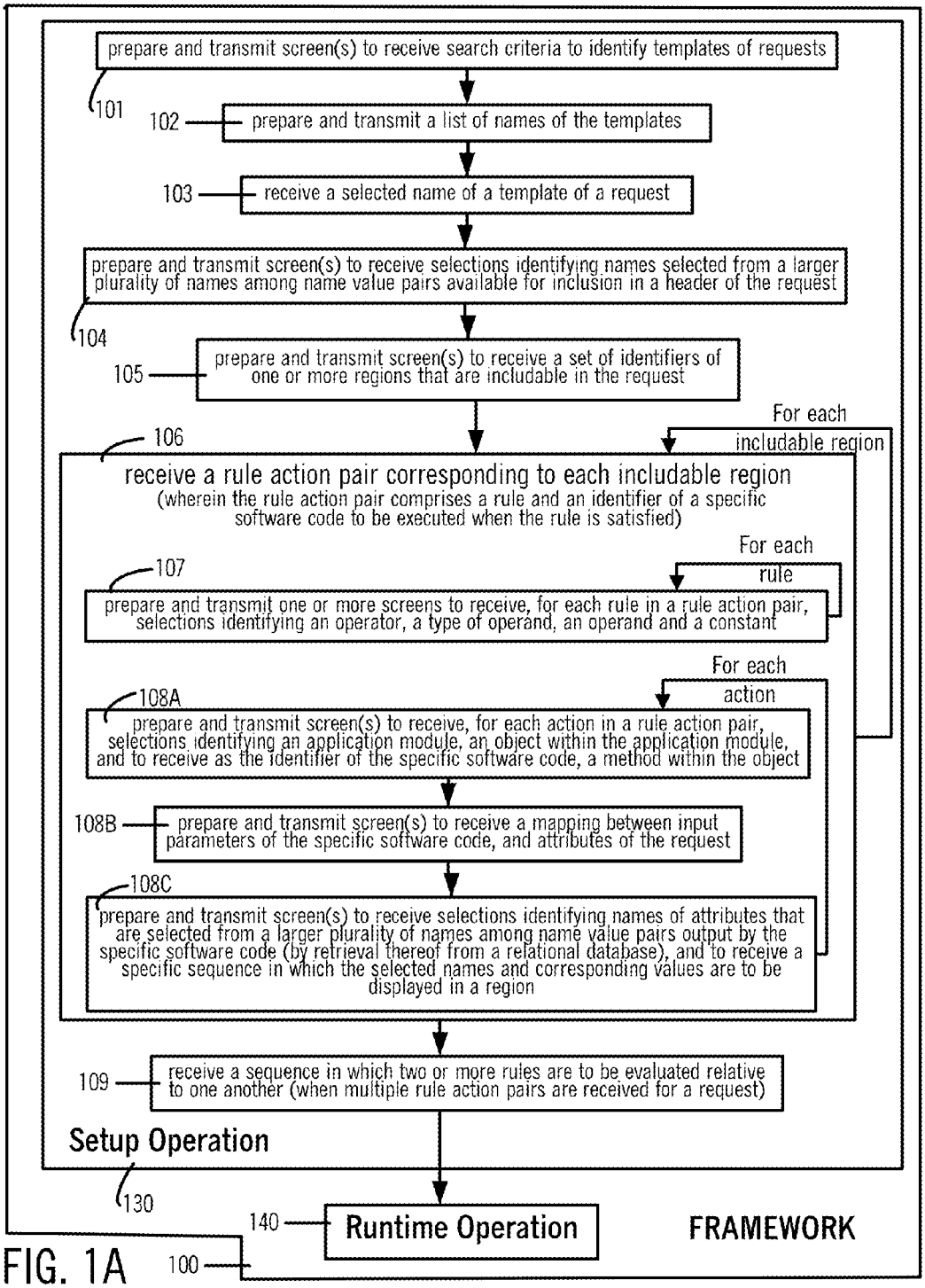

prepare and transmit screen(s) to receive search criteria to identify templates of requests
101
102
prepare and transmit a list of names of the templates
103
receive a selected name of a template of a request
prepare and transmit screen(s) to receive selections identifying names selected from a larger plurality of names among name value pairs available for inclusion in a header of the request
104
105
prepare and transmit screen(s) to receive a set of identifiers of one or more regions that are includable in the request
For each includable region
106
receive a rule action pair corresponding to each includable region
(wherein the rule action pair comprises a rule and an identifier of a specific software code to be executed when the rule is satisfied)
For each rule
107
prepare and transmit one or more screens to receive, for each rule in a rule action pair, selections identifying an operator, a type of operand, an operand and a constant
For each action
108A
prepare and transmit screen(s) to receive, for each action in a rule action pair, selections identifying an application module, an object within the application module, and to receive as the identifier of the specific software code, a method within the object
108B
prepare and transmit screen(s) to receive a mapping between input parameters of the specific software code, and attributes of the request
108C
prepare and transmit screen(s) to receive selections identifying names of attributes that are selected from a larger plurality of names among name value pairs output by the specific software code (by retrieval thereof from a relational database), and to receive a specific sequence in which the selected names and corresponding values are to be displayed in a region
109
receive a sequence in which two or more rules are to be evaluated relative to one another (when multiple rule action pairs are received for a request)
Setup Operation
130
140
Runtime Operation
FRAMEWORK
100

FIG. 1A

FIG. 1B

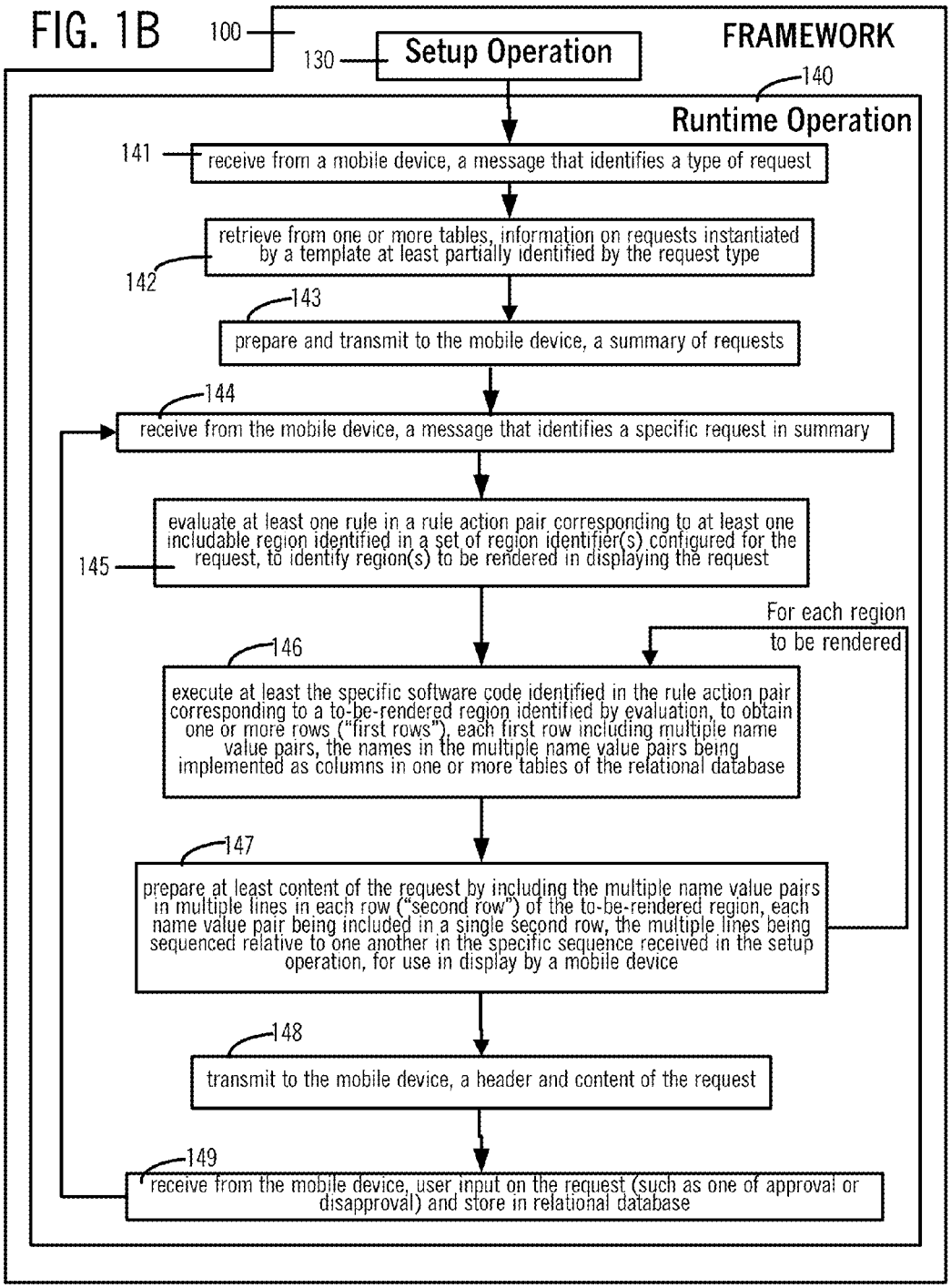
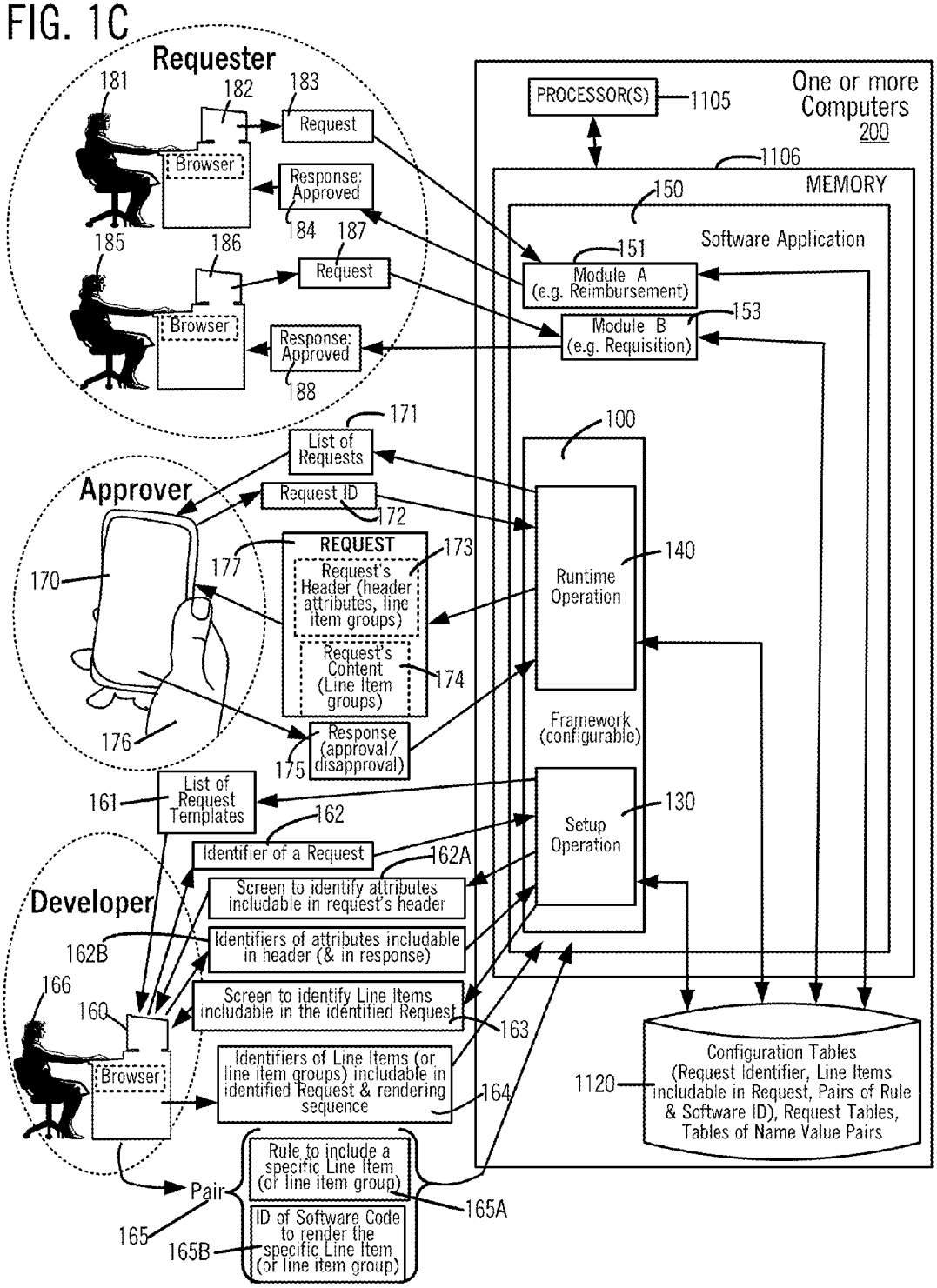

100
FRAMEWORK
130
Setup Operation
140
Runtime Operation
141
receive from a mobile device, a message that identifies a type of request
142
retrieve from one or more tables, information on requests instantiated by a template at least partially identified by the request type
143
prepare and transmit to the mobile device, a summary of requests
144
receive from the mobile device, a message that identifies a specific request in summary
145
evaluate at least one rule in a rule action pair corresponding to at least one includable region identified in a set of region identifier(s) configured for the request, to identify region(s) to be rendered in displaying the request
For each region to be rendered
146
execute at least the specific software code identified in the rule action pair corresponding to a to-be-rendered region identified by evaluation, to obtain one or more rows ("first rows"), each first row including multiple name value pairs, the names in the multiple name value pairs being implemented as columns in one or more tables of the relational database
147
prepare at least content of the request by including the multiple name value pairs in multiple lines in each row ("second row") of the to-be-rendered region, each name value pair being included in a single second row, the multiple lines being sequenced relative to one another in the specific sequence received in the setup operation, for use in display by a mobile device
148
transmit to the mobile device, a header and content of the request
149
receive from the mobile device, user input on the request (such as one of approval or disapproval) and store in relational database

FIG. 1C


Requester
181
182
183
Request
Browser
Response: Approved
184
187
185
186
Request
Browser
Response: Approved
188
PROCESSOR(S)
1105
One or more Computers
200
1106
MEMORY
150
Software Application
151
Module A (e.g. Reimbursement)
153
Module B (e.g. Requisition)
171
List of Requests
100
Approver
Request ID
172
REQUEST
173
Request's Header (header attributes, line item groups)
177
170
Request's Content (Line Item groups)
174
140
Runtime Operation
176
Response (approval/ disapproval)
175
Framework (configurable)
List of Request Templates
161
162
Identifier of a Request
130
Setup Operation
162A
Developer
Screen to identify attributes includable in request's header
Identifiers of attributes includable in header (& in response)
162B
166
160
Screen to identify Line Items includable in the identified Request
163
Browser
Identifiers of Line Items (or line item groups) includable in identified Request & rendering sequence
164
1120
Configuration Tables (Request Identifier, Line Items includable in Request, Pairs of Rule & Software ID), Request Tables, Tables of Name Value Pairs
Pair
Rule to include a specific Line Item (or line item group)
165A
165
ID of Software Code to render the specific Line Item (or line item group)
165B

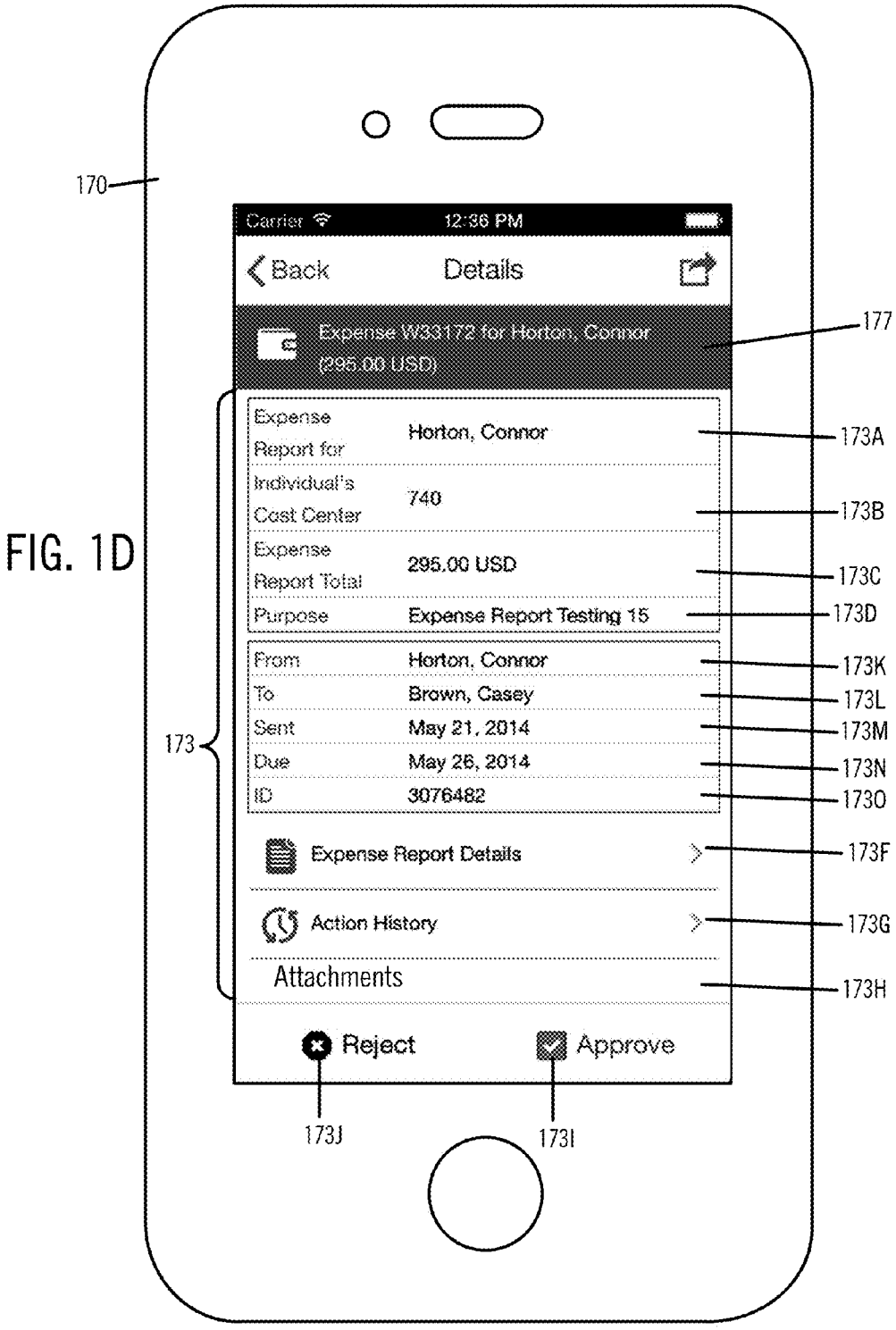

170
Carrier
12:36 PM
Back
Details
Expense W33172 for Horton, Connor
(295.00 USD)
177
Expense Report for
Horton, Connor
173A
Individual's Cost Center
740
173B
Expense Report Total
295.00 USD
173C
Purpose
Expense Report Testing 15
173D
173
From
Horton, Connor
173K
To
Brown, Casey
173L
Sent
May 21, 2014
173M
Due
May 26, 2014
173N
ID
3076482
173O
Expense Report Details
173F
Action History
173G
Attachments
173H
Reject
Approve
173J
173I

FIG. 1D

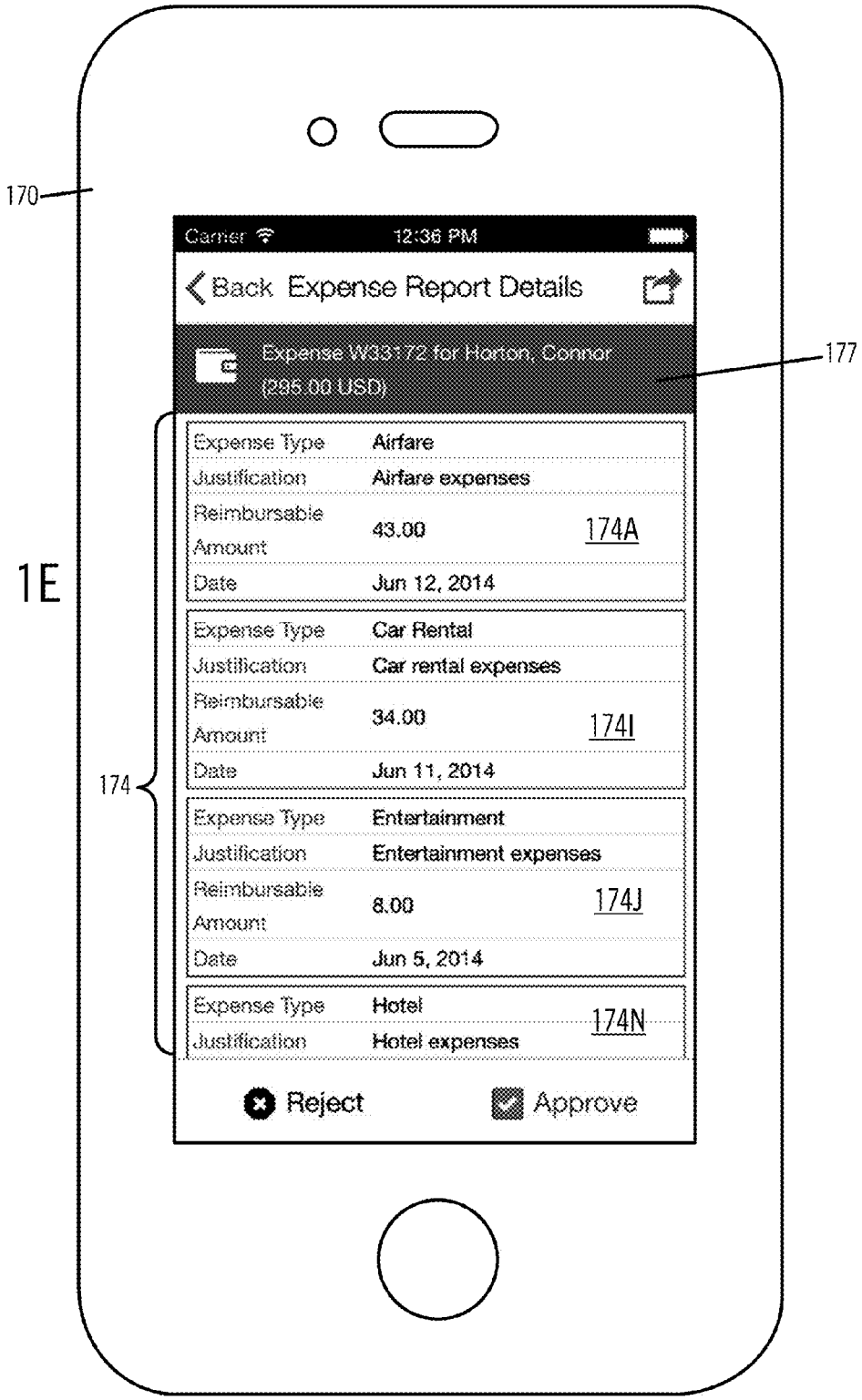

170
Carrier
12:36 PM
Back Expense Report Details
Expense W33172 for Horton, Connor
(295.00 USD)
177
Expense Type Airfare
Justification Airfare expenses
Reimbursable Amount 43.00
174A
Date Jun 12, 2014
Expense Type Car Rental
Justification Car rental expenses
Reimbursable Amount 34.00
174I
Date Jun 11, 2014
174
Expense Type Entertainment
Justification Entertainment expenses
Reimbursable Amount 8.00
174J
Date Jun 5, 2014
Expense Type Hotel
Justification Hotel expenses
174N
Reject
Approve

FIG. 1E

FIG. 1F

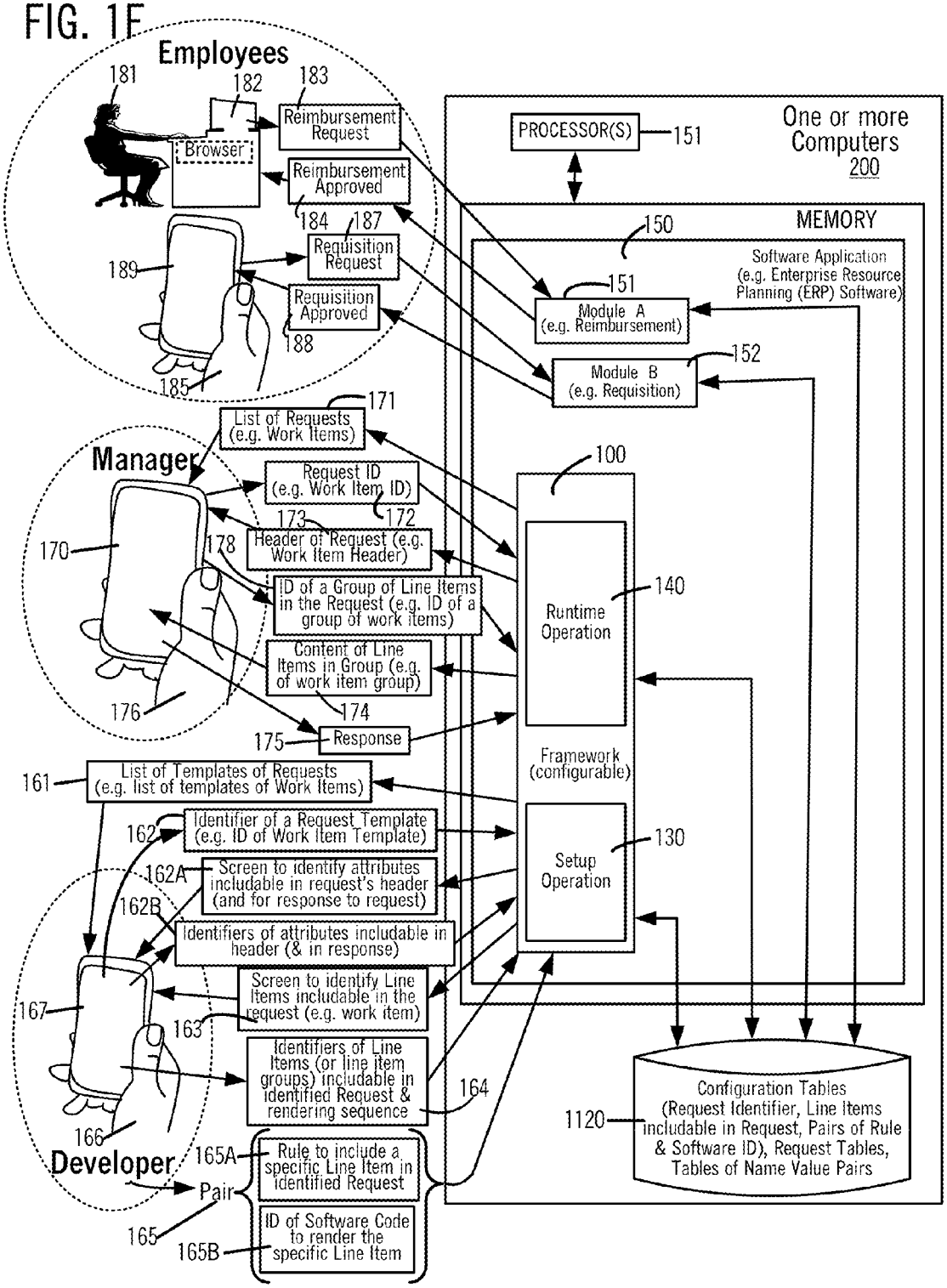
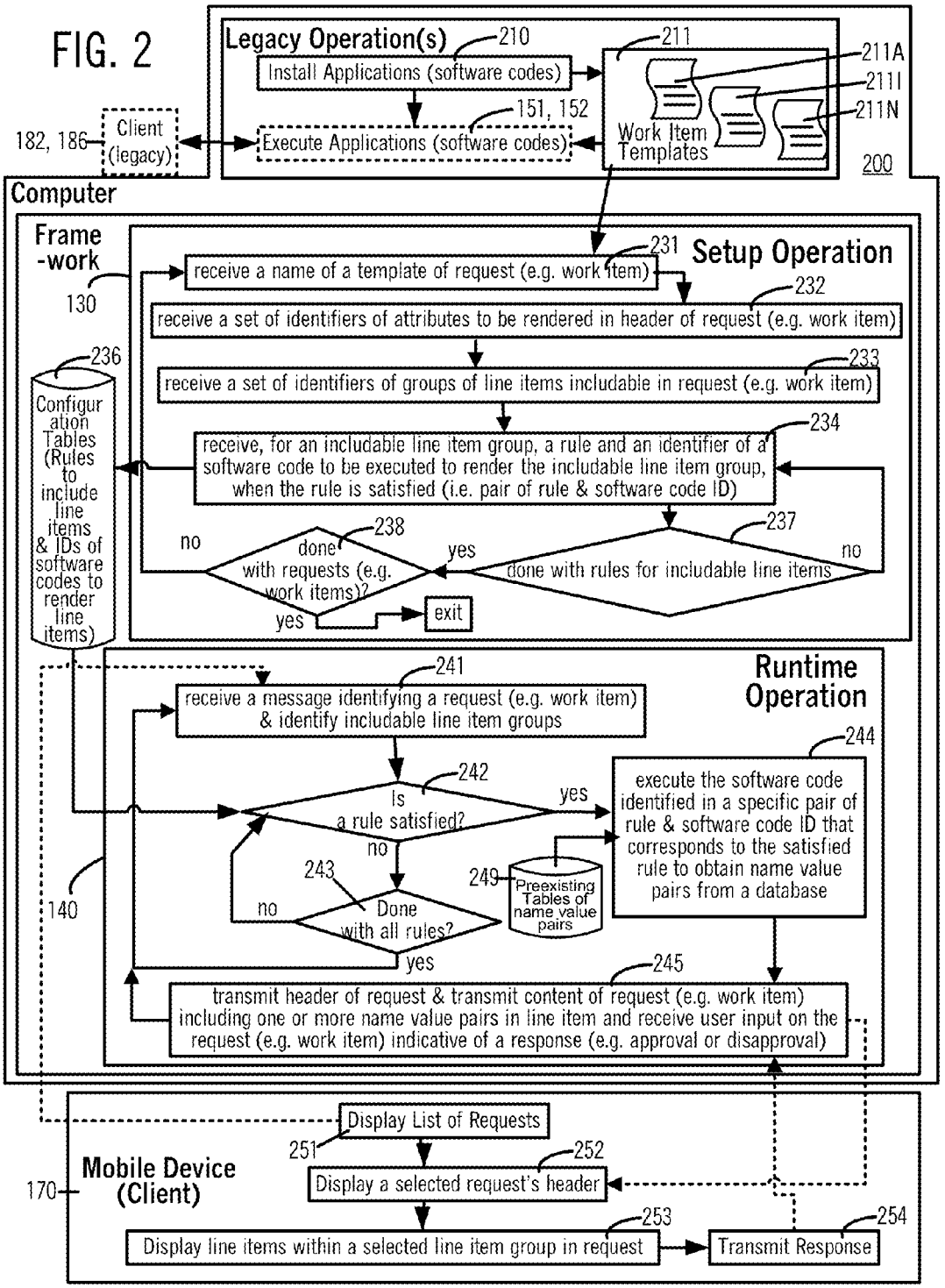

Employees
181
182
183
Browser
Reimbursement Request
Reimbursement Approved
184
187
Requisition Request
189
Requisition Approved
188
185
171
List of Requests (e.g. Work Items)
Manager
Request ID (e.g. Work Item ID)
173
172
170
178
Header of Request (e.g. Work Item Header)
ID of a Group of Line Items in the Request (e.g. ID of a group of work items)
Content of Line Items in Group (e.g. of work item group)
176
174
175
Response
161
List of Templates of Requests (e.g. list of templates of Work Items)
162
Identifier of a Request Template (e.g. ID of Work Item Template)
162A
Screen to identify attributes includable in request's header (and for response to request)
162B
Identifiers of attributes includable in header (& in response)
167
Screen to identify Line Items includable in the request (e.g. work item)
163
Identifiers of Line Items (or line item groups) includable in identified Request & rendering sequence
164
166
Developer
165A
Rule to include a specific Line Item in identified Request
Pair
165
ID of Software Code to render the specific Line Item
165B
PROCESSOR(S)
151
One or more Computers 200
MEMORY
150
Software Application (e.g. Enterprise Resource Planning (ERP) Software)
151
Module A (e.g. Reimbursement)
152
Module B (e.g. Requisition)
100
Runtime Operation
140
Framework (configurable)
Setup Operation
130
Configuration Tables (Request Identifier, Line Items includable in Request, Pairs of Rule & Software ID), Request Tables, Tables of Name Value Pairs
1120

FIG. 2


Legacy Operation(s)
210
Install Applications (software codes)
211
211A
211I
211N
Work Item Templates
151, 152
Execute Applications (software codes)
182, 186
Client (legacy)
200
Computer
Frame -work
130
231
Setup Operation
receive a name of a template of request (e.g. work item)
232
receive a set of identifiers of attributes to be rendered in header of request (e.g. work item)
233
receive a set of identifiers of groups of line items includable in request (e.g. work item)
234
receive, for an includable line item group, a rule and an identifier of a software code to be executed to render the includable line item group, when the rule is satisfied (i.e. pair of rule & software code ID)
236
Configur ation Tables (Rules to include line items & IDs of software codes to render line items)
237
done with rules for includable line items
no
yes
238
done with requests (e.g. work items)?
no
yes
exit
Runtime Operation
241
receive a message identifying a request (e.g. work item) & identify includable line item groups
242
Is a rule satisfied?
yes
no
244
execute the software code identified in a specific pair of rule & software code ID that corresponds to the satisfied rule to obtain name value pairs from a database
243
Done with all rules?
no
yes
249
Preexisting Tables of name value pairs
140
245
transmit header of request & transmit content of request (e.g. work item) including one or more name value pairs in line item and receive user input on the request (e.g. work item) indicative of a response (e.g. approval or disapproval)
Mobile Device (Client)
170
Display List of Requests
251
252
Display a selected request's header
253
Display line items within a selected line item group in request
254
Transmit Response

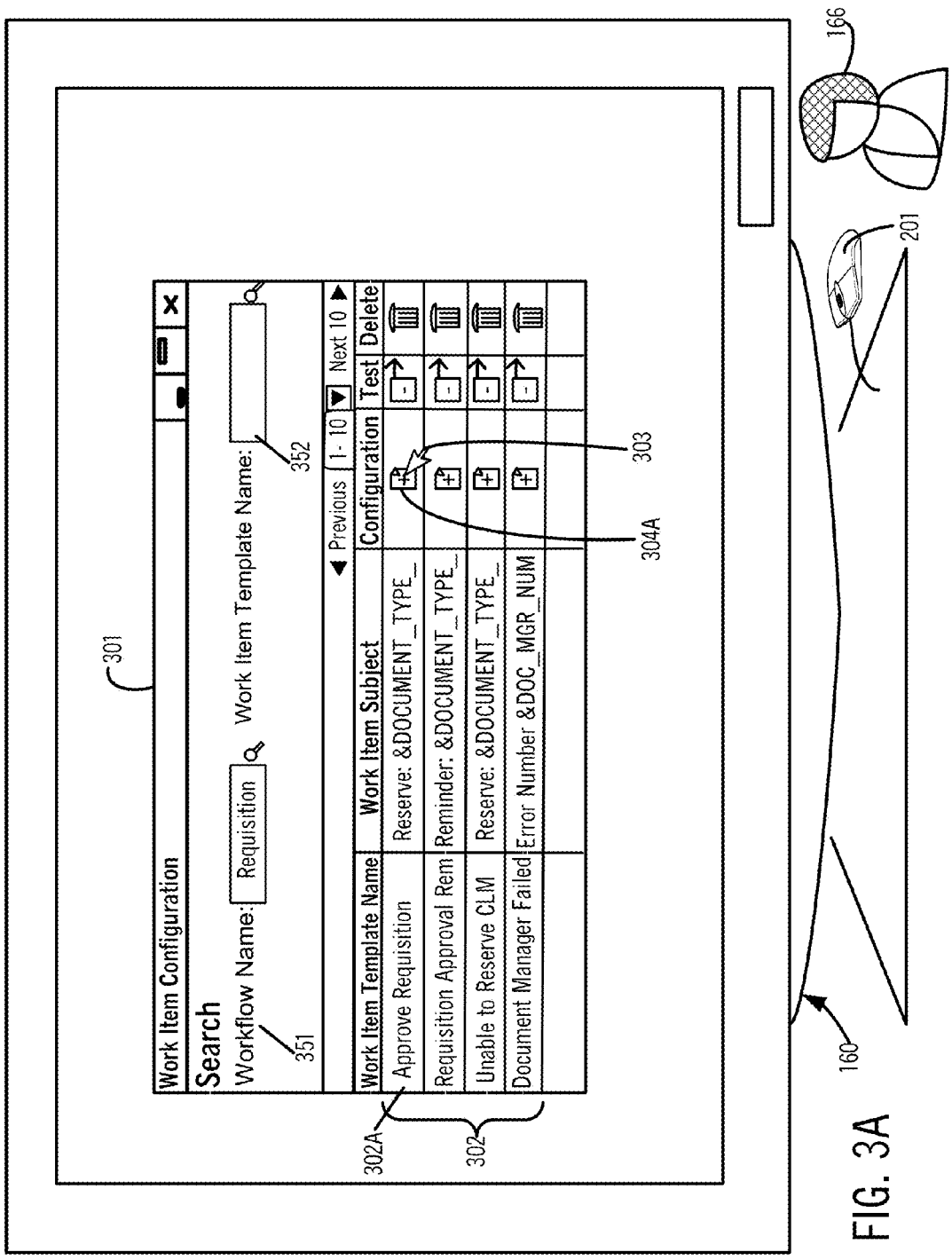

301
Work Item Configuration
Search
Workflow Name: Requisition
351
Work Item Template Name:
352
Previous 1 - 10 Next 10
Work Item Template Name
Work Item Subject
Configuration
Test
Delete
Approve Requisition
Reserve: &DOCUMENT_TYPE_
Requisition Approval Rem
Reminder: &DOCUMENT_TYPE_
Unable to Reserve CLM
Reserve: &DOCUMENT_TYPE_
Document Manager Failed
Error Number &DOC_MGR_NUM
302A
302
303
304A
166
201
160

FIG. 3A

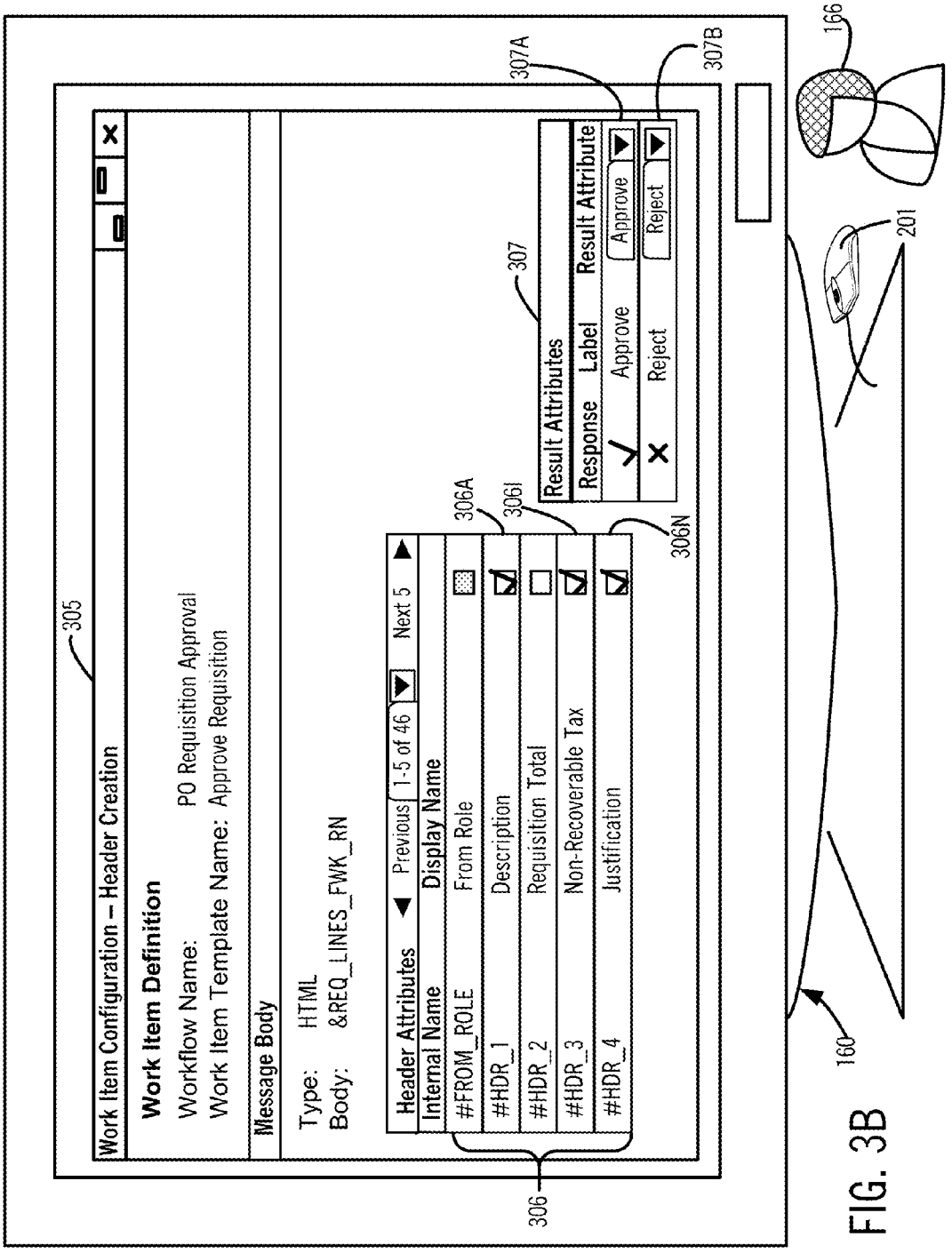

305
Work Item Configuration – Header Creation
Work Item Definition
Workflow Name: PO Requisition Approval
Work Item Template Name: Approve Requisition
Message Body
Type: HTML
Body: &REQ_LINES_FWK_RN
Header Attributes
Previous
1-5 of 46
Next 5
Internal Name
Display Name
#FROM_ROLE
From Role
#HDR_1
Description
#HDR_2
Requisition Total
#HDR_3
Non-Recoverable Tax
#HDR_4
Justification
306
306A
306I
306N
Result Attributes
Response
Label
Result Attribute
Approve
Approve
Reject
Reject
307
307A
307B
166
201
160

FIG. 3B

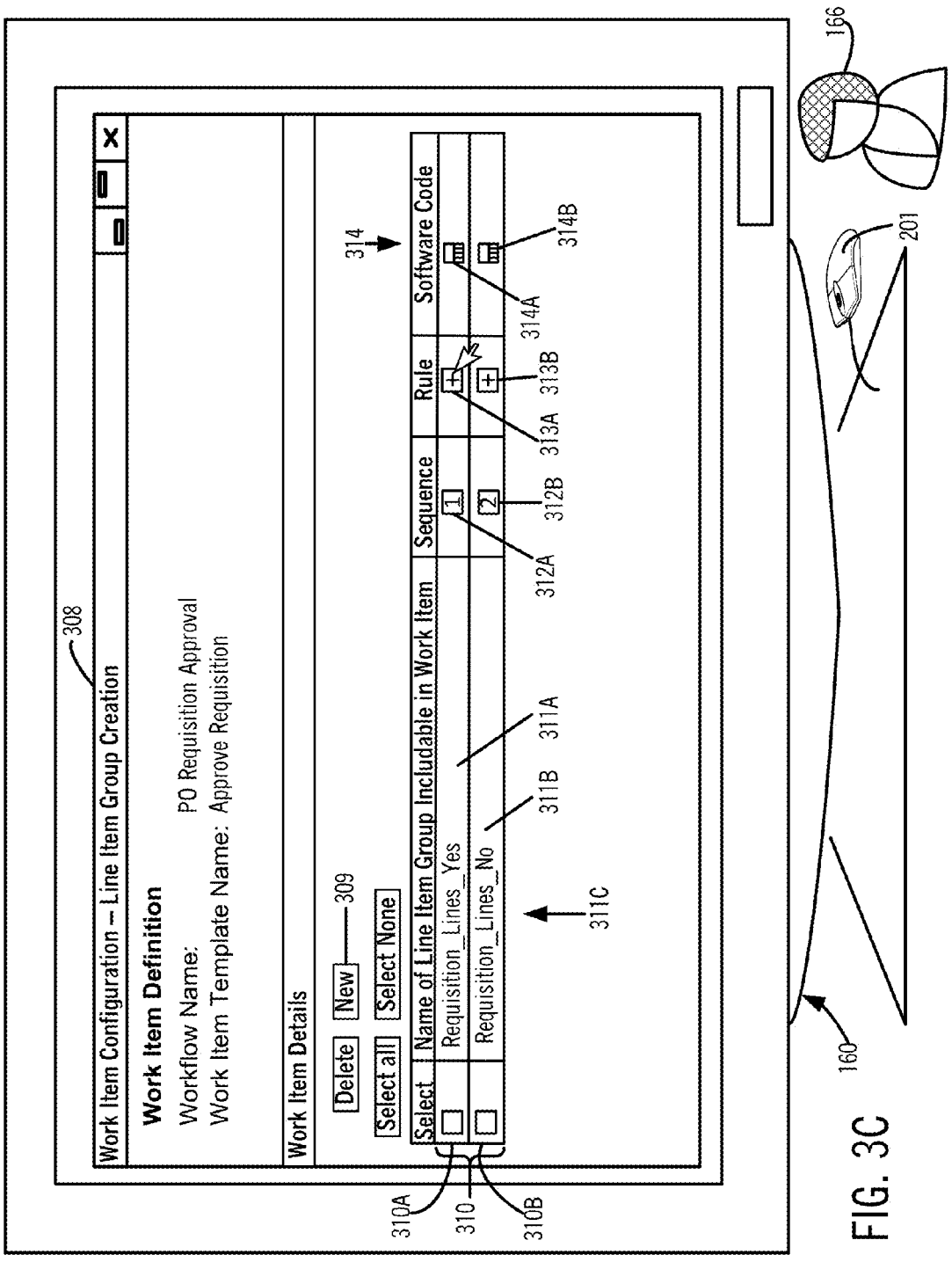

Work Item Configuration – Line Item Group Creation
308
Work Item Definition
Workflow Name: PO Requisition Approval
Work Item Template Name: Approve Requisition
Work Item Details
Delete
New
309
Select all
Select None
314
Select
Name of Line Item Group Includable in Work Item
Sequence
Rule
Software Code
Requisition_Lines_Yes
Requisition_Lines_No
1
2
310A
310
310B
311A
311B
311C
312A
312B
313A
313B
314A
314B
160
166
201

FIG. 3C

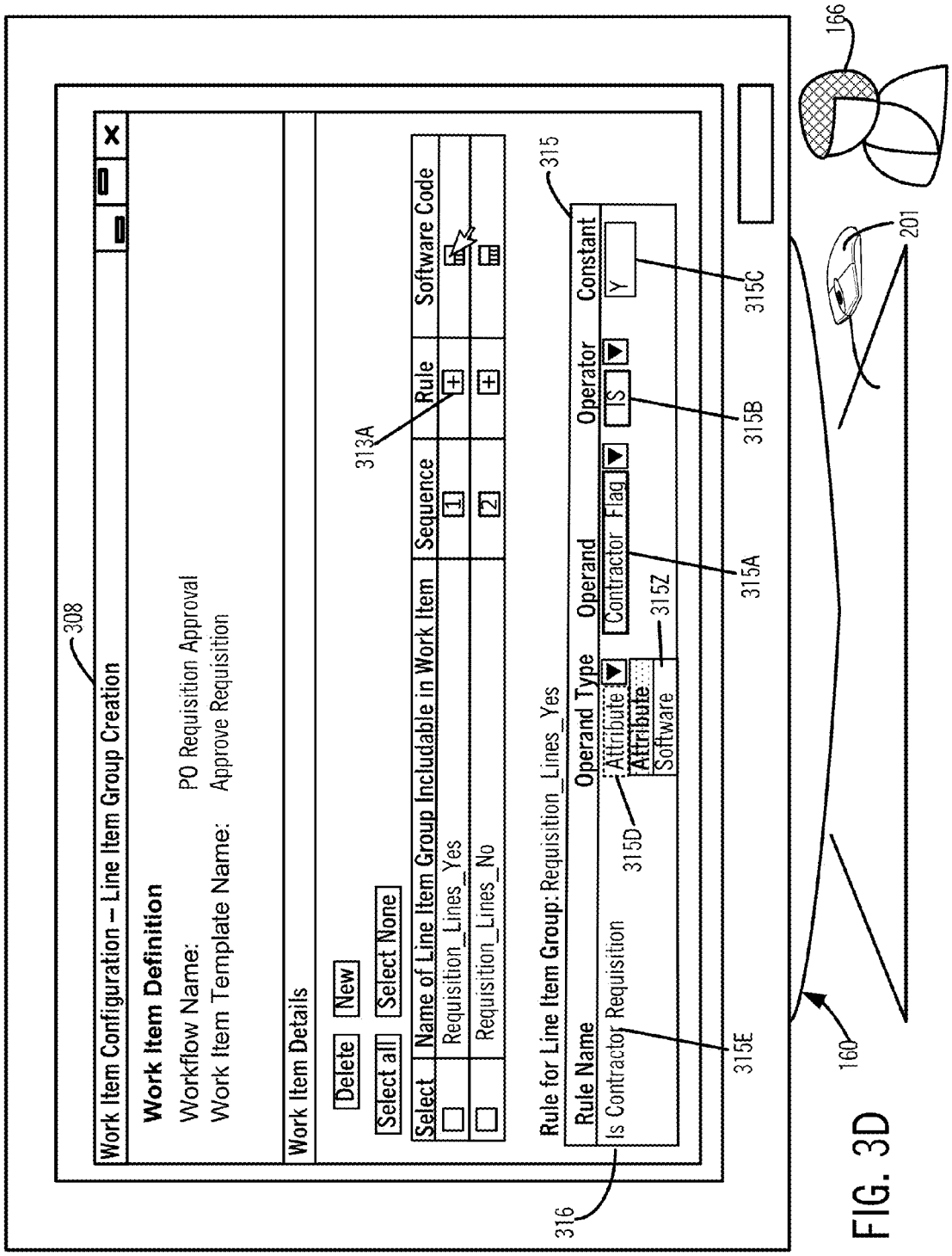

Work Item Configuration – Line Item Group Creation
308
Work Item Definition
Workflow Name: PO Requisition Approval
Work Item Template Name: Approve Requisition
Work Item Details
Delete
New
Select all
Select None
Select
Name of Line Item Group Includable in Work Item
Sequence
Rule
Software Code
Requisition_Lines_Yes
1
Requisition_Lines_No
2
313A
Rule for Line Item Group: Requisition_Lines_Yes
315
Rule Name
Operand Type
Operand
Operator
Constant
Is Contractor Requisition
Attribute
Contractor_Flag
IS
Y
Attribute
Software
315D
315Z
315A
315B
315C
316
315E
160
166
201

FIG. 3D

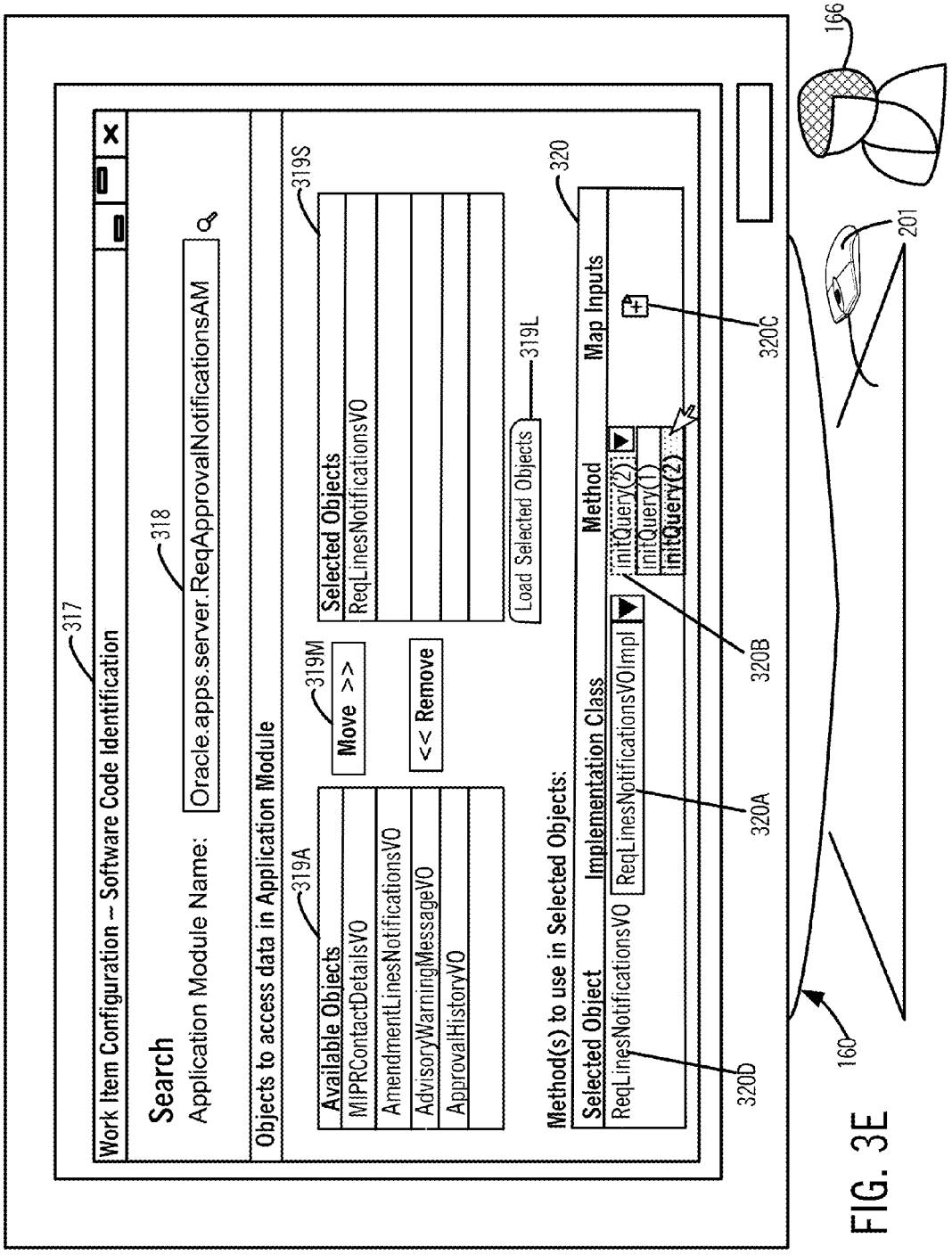

317
Work Item Configuration -- Software Code Identification
Search
Application Module Name:
318
Oracle.apps.server.ReqApprovalNotificationsAM
Objects to access data in Application Module
319A
Available Objects
MIPRContactDetailsVO
AmendmentLinesNotificationsVO
AdvisoryWarningMessageVO
ApprovalHistoryVO
319M
Move >>
<< Remove
319S
Selected Objects
ReqLinesNotificationsVO
Load Selected Objects
319L
320
Method(s) to use in Selected Objects:
Selected Object
Implementation Class
Method
Map Inputs
ReqLinesNotificationsVO
ReqLinesNotificationsVOImpl
initQuery(2)
initQuery(1)
initQuery(2)
320D
320A
320B
320C
160
166
201

FIG. 3E

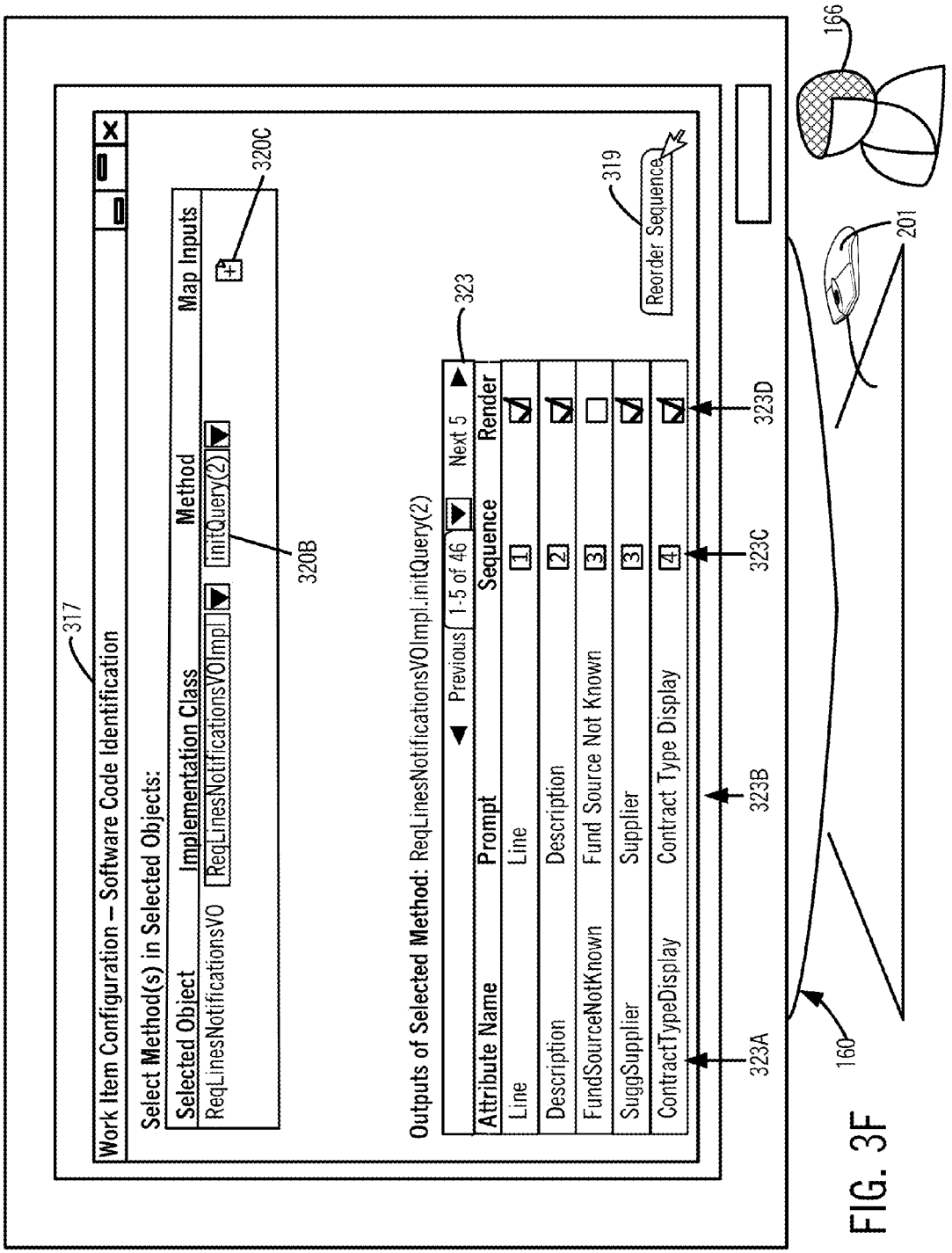

317
Work Item Configuration – Software Code Identification
Select Method(s) in Selected Objects:
Selected Object
Implementation Class
Method
Map Inputs
ReqLinesNotificationsVO
ReqLinesNotificationsVOImpl
initQuery(2)
320B
320C
Outputs of Selected Method: ReqLinesNotificationsVOImpl.initQuery(2)
Previous 1-5 of 46
Next 5
323
Attribute Name
Prompt
Sequence
Render
Line
Line
1
Description
Description
2
FundSourceNotKnown
Fund Source Not Known
3
SuggSupplier
Supplier
3
ContractTypeDisplay
Contract Type Display
4
Reorder Sequence
319
323A
323B
323C
323D
160
166
201

FIG. 3F

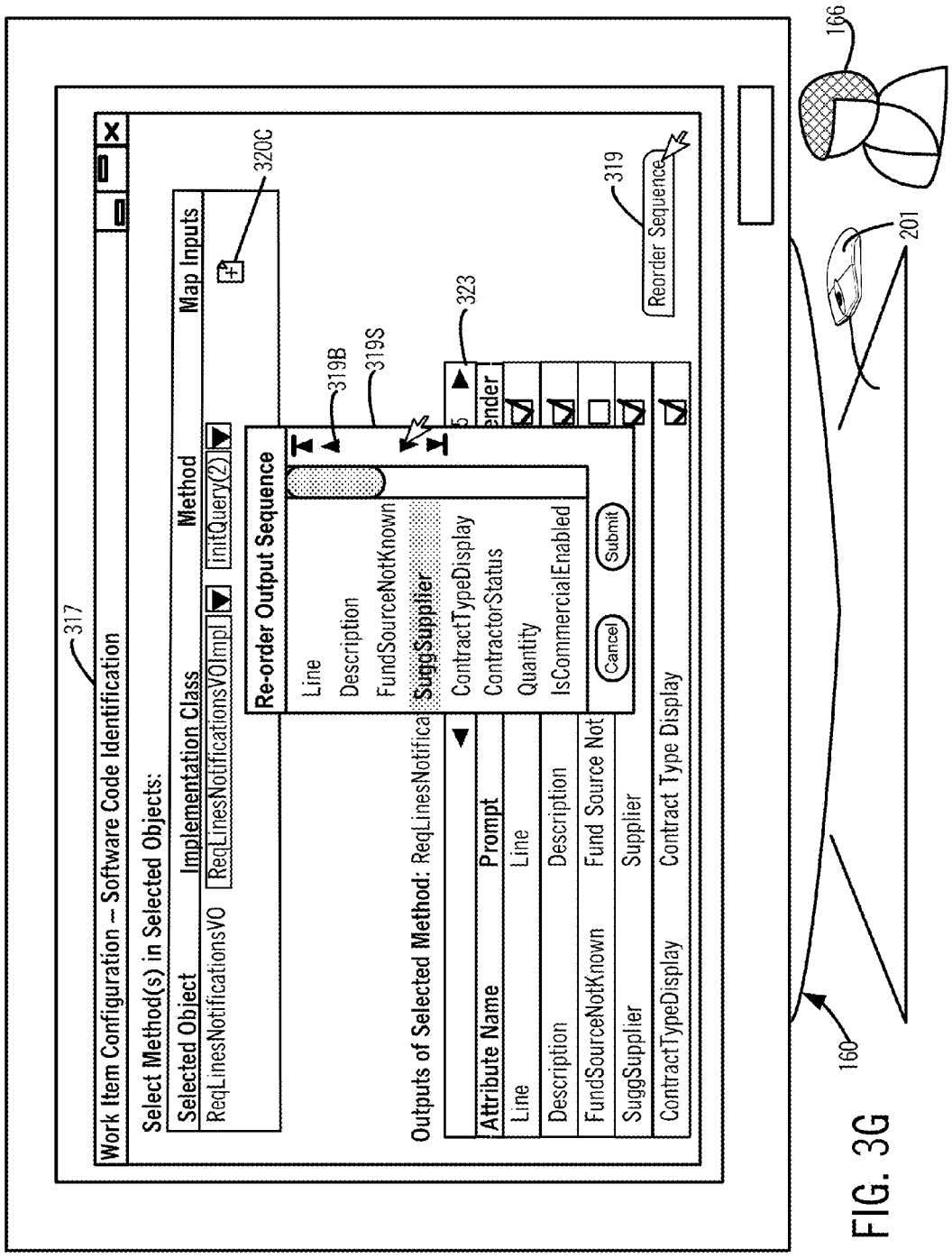

317
Work Item Configuration -- Software Code Identification
Select Method(s) in Selected Objects:
Selected Object
Implementation Class
Method
Map Inputs
ReqLinesNotificationsVO
ReqLinesNotificationsVOImpl
initQuery(2)
320C
Re-order Output Sequence
Line
Description
FundSourceNotKnown
SuggSupplier
319B
319S
323
ContractTypeDisplay
ContractorStatus
Quantity
IsCommercialEnabled
Cancel
Submit
319
Reorder Sequence
Outputs of Selected Method: ReqLinesNotifica
Attribute Name
Prompt
Line
Description
FundSourceNotKnown
Fund Source Not
SuggSupplier
Supplier
ContractTypeDisplay
Contract Type Display
166
201
160

FIG. 3G

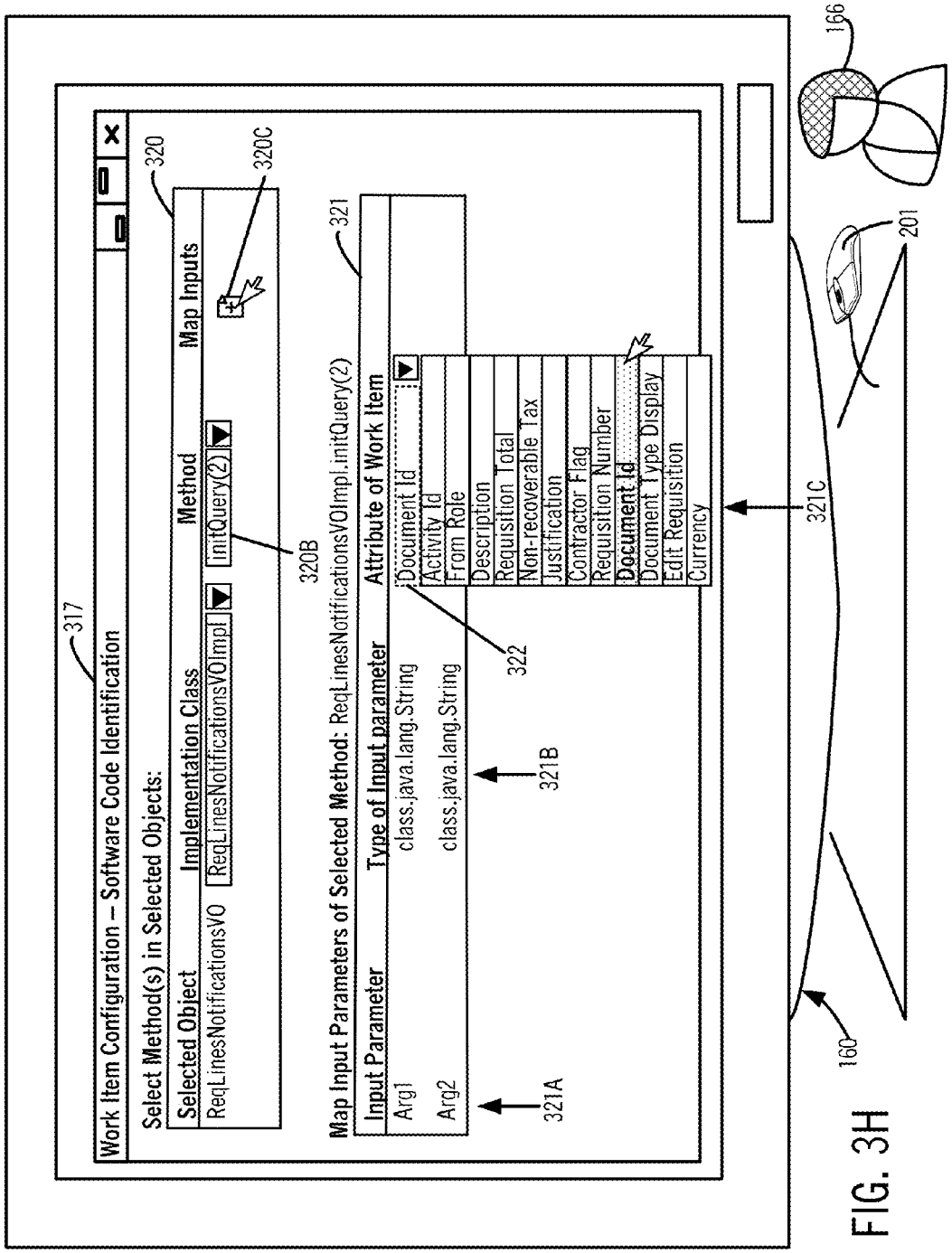

Work Item Configuration – Software Code Identification
317
Select Method(s) in Selected Objects:
320
Selected Object
Implementation Class
Method
Map Inputs
ReqLinesNotificationsVO
ReqLinesNotificationsVOImpl
InitQuery(2)
320C
320B
Map Input Parameters of Selected Method: ReqLinesNotificationsVOImpl.initQuery(2)
321
Input Parameter
Type of Input parameter
Attribute of Work Item
Arg1
class.java.lang.String
Arg2
class.java.lang.String
Document Id
Activity Id
From Role
Description
Requisition Total
Non-recoverable Tax
Justification
Contractor Flag
Requisition Number
Document Id
Document Type Display
Edit Requisition
Currency
321A
321B
322
321C
166
201
160

FIG. 3H

FIG. 4A

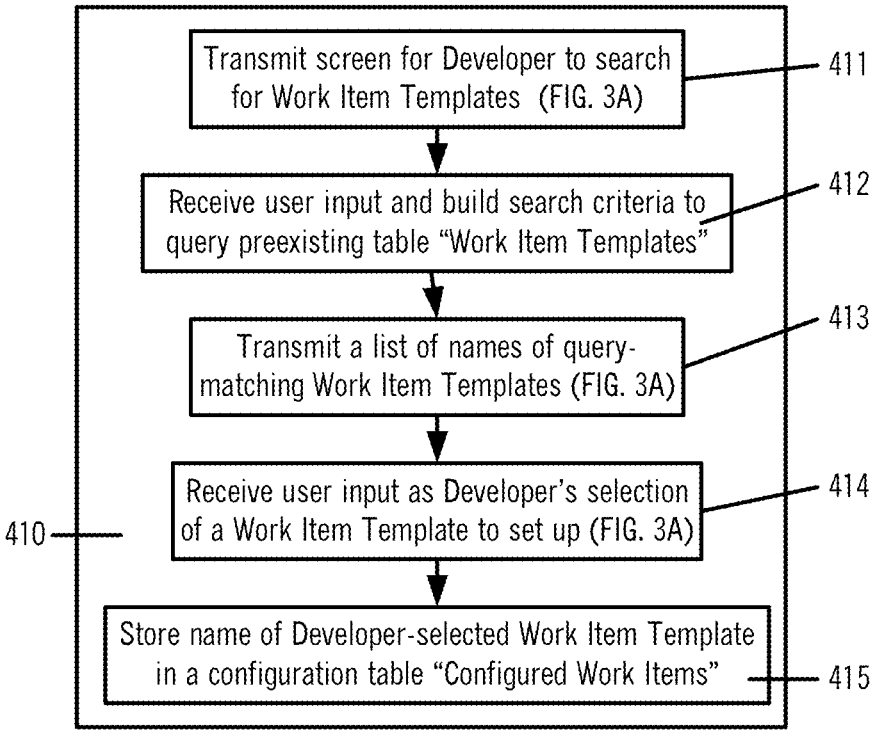

Transmit screen for Developer to search for Work Item Templates (FIG. 3A)
411
Receive user input and build search criteria to query preexisting table "Work Item Templates"
412
Transmit a list of names of query-matching Work Item Templates (FIG. 3A)
413
Receive user input as Developer's selection of a Work Item Template to set up (FIG. 3A)
414
410
Store name of Developer-selected Work Item Template in a configuration table "Configured Work Items"
415

FIG. 4B

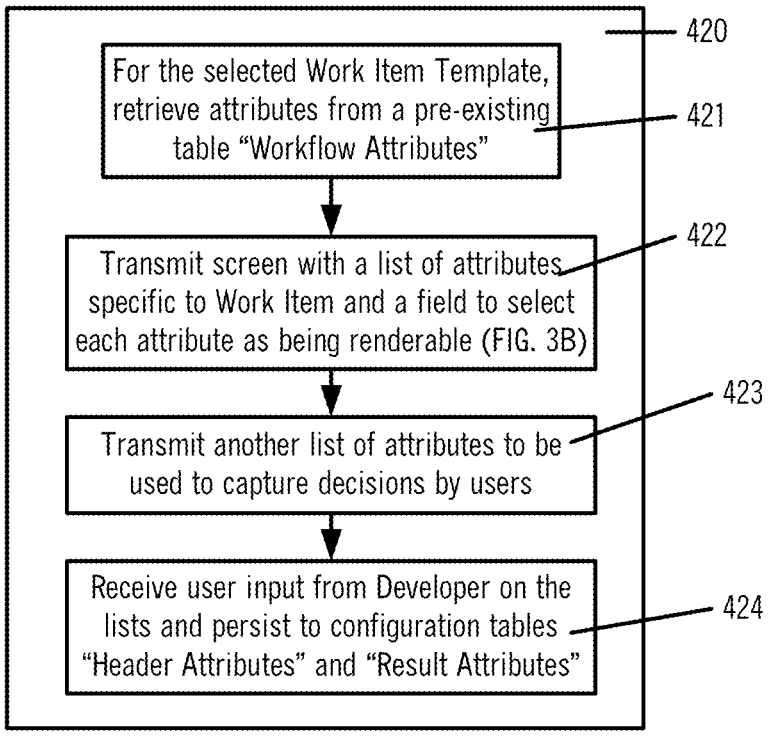

420
For the selected Work Item Template, retrieve attributes from a pre-existing table "Workflow Attributes"
421
Transmit screen with a list of attributes specific to Work Item and a field to select each attribute as being renderable (FIG. 3B)
422
Transmit another list of attributes to be used to capture decisions by users
423
Receive user input from Developer on the lists and persist to configuration tables "Header Attributes" and "Result Attributes"
424

FIG. 4C

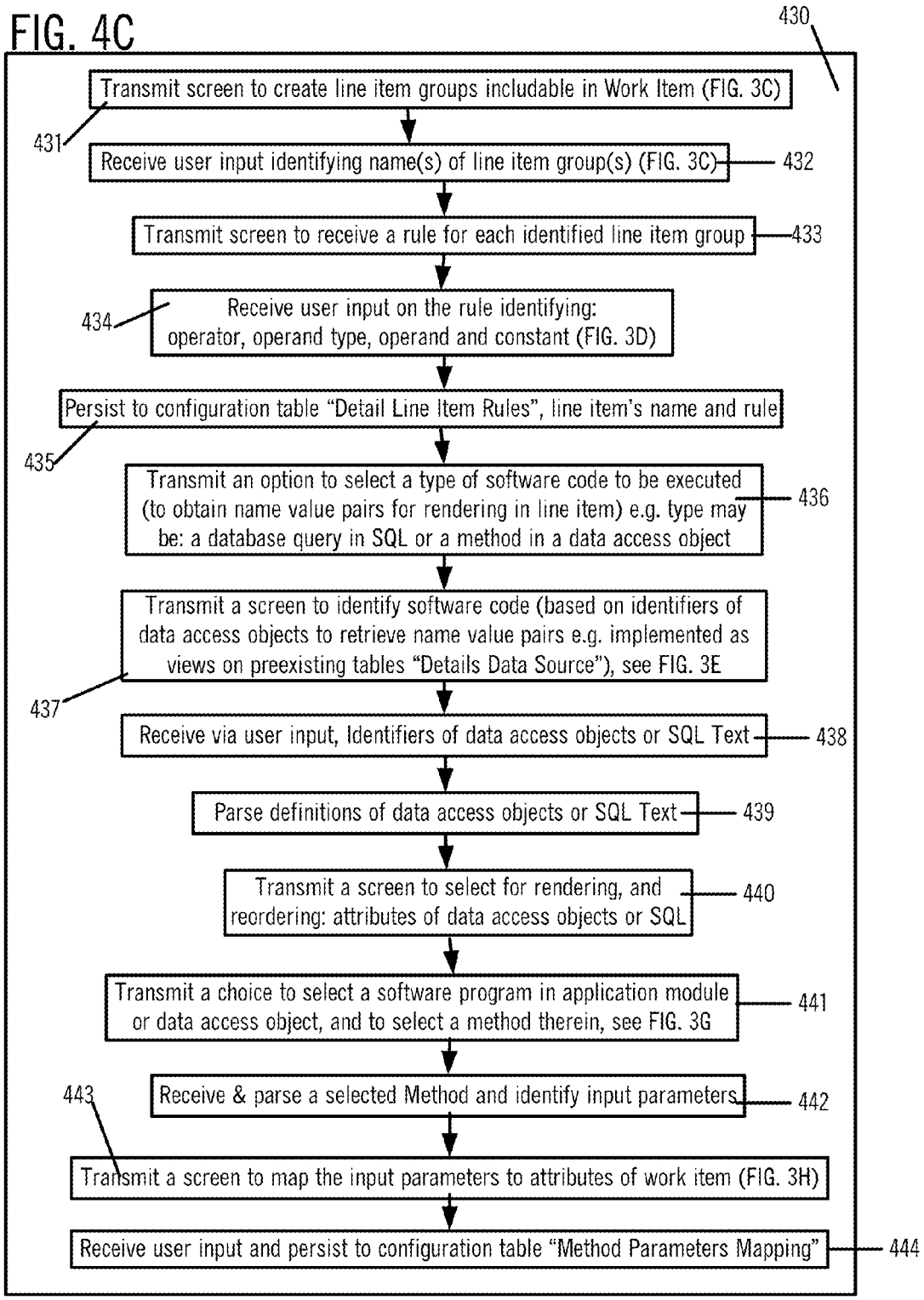

430
Transmit screen to create line item groups includable in Work Item (FIG. 3C)
431
Receive user input identifying name(s) of line item group(s) (FIG. 3C)
432
Transmit screen to receive a rule for each identified line item group
433
434
Receive user input on the rule identifying: operator, operand type, operand and constant (FIG. 3D)
Persist to configuration table "Detail Line Item Rules", line item's name and rule
435
Transmit an option to select a type of software code to be executed (to obtain name value pairs for rendering in line item) e.g. type may be: a database query in SQL or a method in a data access object
436
Transmit a screen to identify software code (based on identifiers of data access objects to retrieve name value pairs e.g. implemented as views on preexisting tables "Details Data Source"), see FIG. 3E
437
Receive via user input, Identifiers of data access objects or SQL Text
438
Parse definitions of data access objects or SQL Text
439
Transmit a screen to select for rendering, and reordering: attributes of data access objects or SQL
440
Transmit a choice to select a software program in application module or data access object, and to select a method therein, see FIG. 3G
441
443
Receive & parse a selected Method and identify input parameters
442
Transmit a screen to map the input parameters to attributes of work item (FIG. 3H)
Receive user input and persist to configuration table "Method Parameters Mapping"
444

FIG. 5A

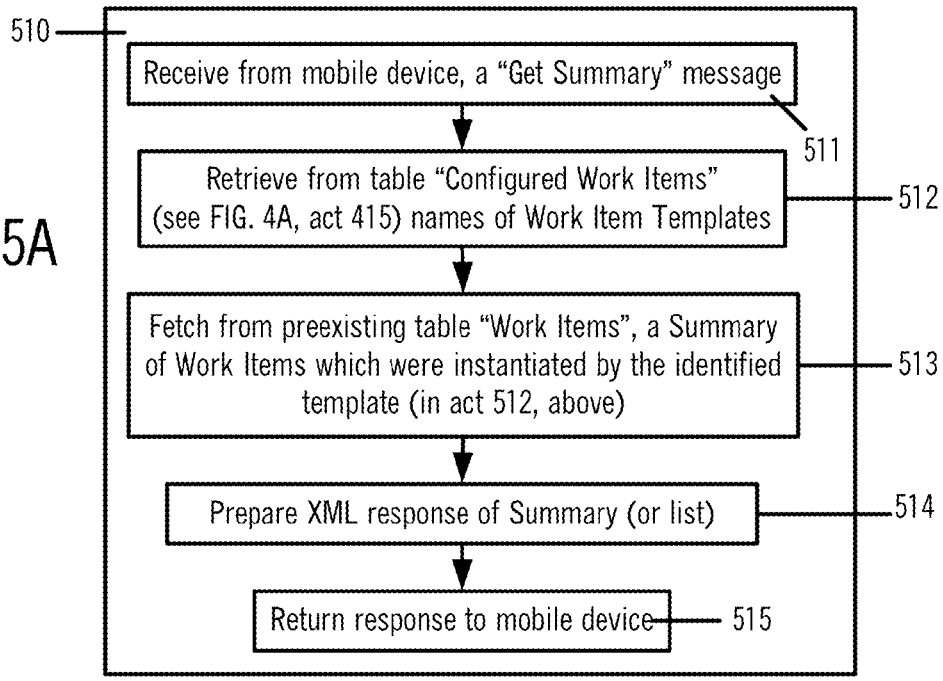
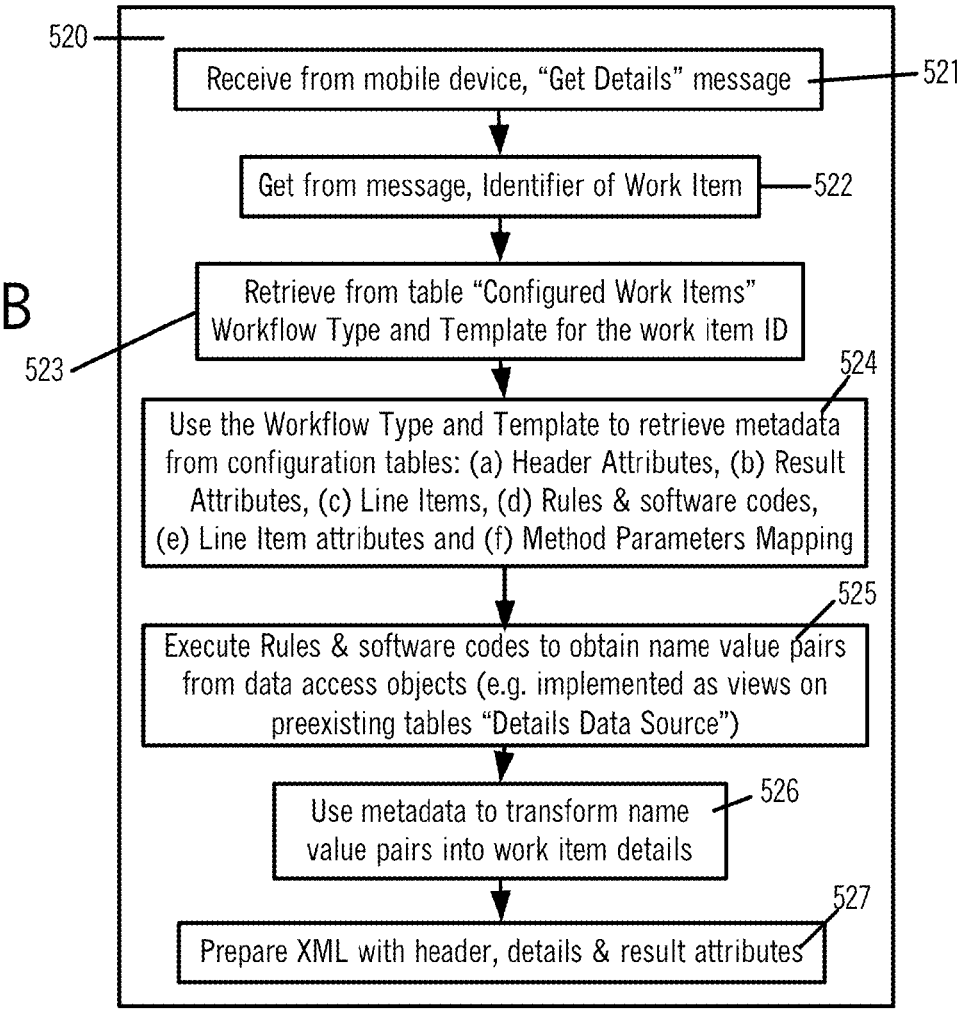

510
Receive from mobile device, a "Get Summary" message
511
Retrieve from table "Configured Work Items" (see FIG. 4A, act 415) names of Work Item Templates
512
Fetch from preexisting table "Work Items", a Summary of Work Items which were instantiated by the identified template (in act 512, above)
513
Prepare XML response of Summary (or list)
514
Return response to mobile device
515

FIG. 5B


520
Receive from mobile device, "Get Details" message
521
Get from message, Identifier of Work Item
522
Retrieve from table "Configured Work Items" Workflow Type and Template for the work item ID
523
524
Use the Workflow Type and Template to retrieve metadata from configuration tables: (a) Header Attributes, (b) Result Attributes, (c) Line Items, (d) Rules & software codes, (e) Line Item attributes and (f) Method Parameters Mapping
525
Execute Rules & software codes to obtain name value pairs from data access objects (e.g. implemented as views on preexisting tables "Details Data Source")
526
Use metadata to transform name value pairs into work item details
527
Prepare XML with header, details & result attributes

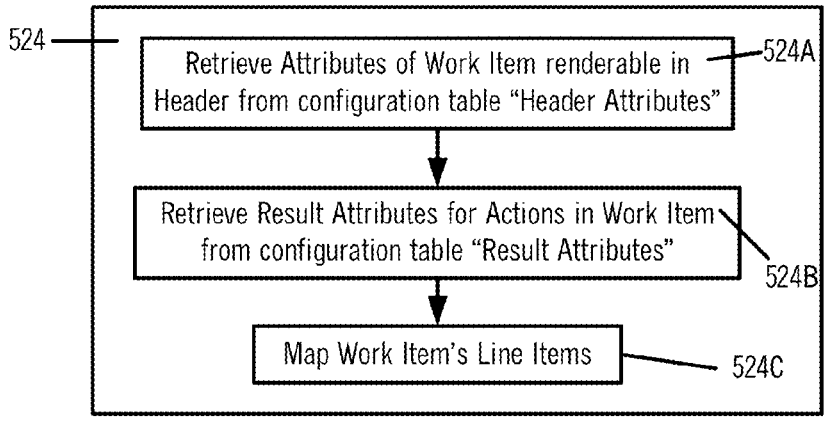

524
Retrieve Attributes of Work Item renderable in Header from configuration table "Header Attributes"
524A
Retrieve Result Attributes for Actions in Work Item from configuration table "Result Attributes"
524B
Map Work Item's Line Items
524C

FIG. 5C

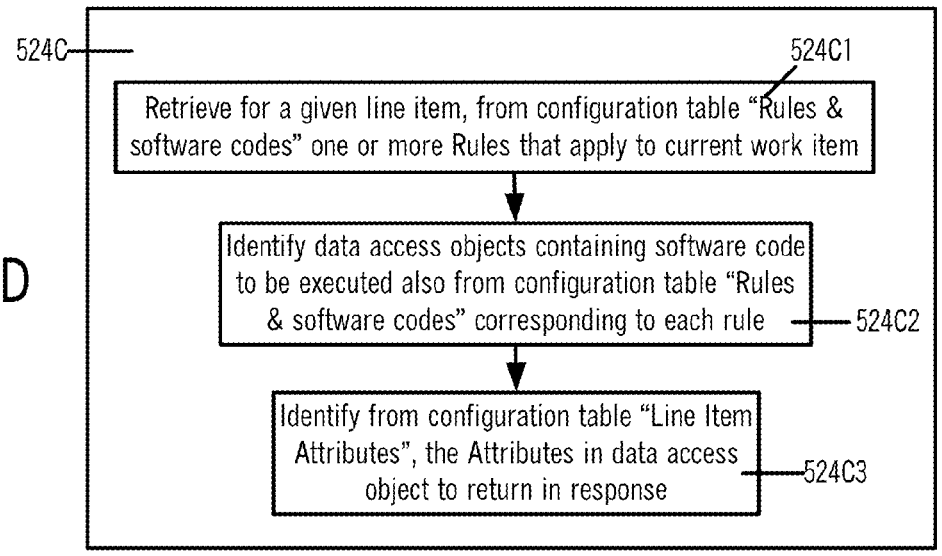

524C
524C1
Retrieve for a given line item, from configuration table "Rules & software codes" one or more Rules that apply to current work item
Identify data access objects containing software code to be executed also from configuration table "Rules & software codes" corresponding to each rule
524C2
Identify from configuration table "Line Item Attributes", the Attributes in data access object to return in response
524C3

FIG. 5D

FIG. 6A

```
<?xml version = '1.0' encoding = 'UTF-8'?>
<response status="200">
  <ns5:output xmlns="http://xmlns.oracle.com/apps/fnd/wf/worklist/service/rt/artifacts/notificationdetails/"
xmlns:ns2="http://xmlns.oracle.com/apps/fnd/wf/worklist/service/rt/artifacts/fault/" xmlns:ns3="http://
xmlns.oracle.com/apps/fnd/wf/worklist/service/rt/artifacts/worklistmgmt/" xmlns:ns4="http://xmlns.oracle.com/
apps/fnd/wf/worklist/service/rt/artifacts/directoryservices/" xmlns:ns5="http://xmlns.oracle.com/apps/fnd/wf/
worklist/service/rt/artifacts/worklist/">
    <notificationdetails>
      <header>
        <region name="Custom Header">
          <view>
            <row>
              <attribute name="Description" id="0">Hand-Rubbed Hardwood Desk Set, Walnut Base with 10 kt Gold
Filled Ball Pen and Pencil</attribute>
              <attribute name="Justification" id="1"/>
              <attribute name="Non-Recoverable Tax" id="2">0.00 USD</attribute>
              <attribute name="Requisition Total" id="3">460.00 USD</attribute>
            </row>
          </view>
        </region>
        <region name="Header">
          <view>
            <row>
              <attribute order="0" type="String" name="From" id="FromUser">Baker, Catherine</attribute>
              <attribute order="1" type="String" name="To" id="ToUser">Brown, Casey</attribute>
              <attribute order="2" type="Date" name="Sent" id="BeginDateF">2014-04-01T04:56:09.000Z</attribute>
              <attribute order="3" type="Date" name="Due" id="DueDateF"/>
              <attribute order="7" type="String" name="ID" id="NotificationId">6275012</attribute>
            </row>
          </view>
        </region>
      </header>
      <body>
        <region id="1022" name="Requisition Lines" part="DETAILS"/>
        <region id="1021" name="Action History" part="HISTORY"/>
      </body>
      <result>
        <attribute type="APPROVE" name="APPROVE" id="0">Approve</attribute>
        <attribute name="APPROVE_AND_FORWARD" id="1">Approve And Forward</attribute>
        <attribute name="FORWARD" id="2">Forward</attribute>
        <attribute type="REJECT" name="REJECT" id="3">Reject</attribute>
      </result>
      <control/>
    </notificationdetails>
  </ns5:output>
</response>
```

FIG. 6B

```
<?xml version = '1.0' encoding = 'UTF-8'?>
<response status="200">
  <ns5:output xmlns="http://xmlns.oracle.com/apps/fnd/wf/worklist/service/rt/artifacts/
notificationdetails/" xmlns:ns2="http://xmlns.oracle.com/apps/fnd/wf/worklist/service/rt/artifacts/
fault/" xmlns:ns3="http://xmlns.oracle.com/apps/fnd/wf/worklist/service/rt/artifacts/worklistmgmt/"
xmlns:ns4="http://xmlns.oracle.com/apps/fnd/wf/worklist/service/rt/artifacts/directoryservices/"
xmlns:ns5="http://xmlns.oracle.com/apps/fnd/wf/worklist/service/rt/artifacts/worklist/">
    <notificationdetails>
      <body>
        <region id="1022" name="Requisition Lines" part="DETAILS">
          <view arrange="detail">
            <row>
              <attribute order="1" type="0" name="Line" id="Line">1</attribute>
              <attribute order="2" type="0" name="Description" id="Description">Hand-Rubbed
Hardwood Desk Set, Walnut Base with 10 kt Gold Filled Ball Pen and Pencil</attribute>
              <attribute order="3" type="0" name="Supplier" id="SuggSupplier">Corporate Express
Office Supply</attribute>
              <attribute order="4" type="0" name="Cost Center" id="CostCenter">740</attribute>
              <attribute order="5" type="0" name="Unit" id="Uom">SET</attribute>
              <attribute order="6" type="0" name="Quantity" id="Quantity">3</attribute>
              <attribute order="7" type="0" name="Price" id="RateConsolidate">100 USD</attribute>
              <attribute order="8" type="0" name="Amount" id="LineAmtConsolidate">300 USD</
attribute>
            </row>
            <row>
              <attribute order="1" type="0" name="Line" id="Line">2</attribute>
              <attribute order="2" type="0" name="Description" id="Description">Lustrous Chrome
Pen and Pencil Set</attribute>
              <attribute order="3" type="0" name="Supplier" id="SuggSupplier">Corporate Express
Office Supply</attribute>
              <attribute order="4" type="0" name="Cost Center" id="CostCenter">740</attribute>
              <attribute order="5" type="0" name="Unit" id="Uom">EA</attribute>
              <attribute order="6" type="0" name="Quantity" id="Quantity">4</attribute>
              <attribute order="7" type="0" name="Price" id="RateConsolidate">40 USD</attribute>
              <attribute order="8" type="0" name="Amount" id="LineAmtConsolidate">160 USD</
attribute>
            </row>
          </view>
        </region>
      </body>
    </notificationdetails>
  </ns5:output>
</response>
```

601A
601B
601C
601D
601E
601F
601G
601H
601
602

FIG. 6C

```
<?xml version = '1.0' encoding = 'UTF-8'?>
<response status="200">
  <ns5:output xmlns="http://xmlns.oracle.com/apps/fnd/wf/worklist/service/rt/artifacts/notificationdetails/"
xmlns:ns2="http://xmlns.oracle.com/apps/fnd/wf/worklist/service/rt/artifacts/fault/" xmlns:ns3="http://
xmlns.oracle.com/apps/fnd/wf/worklist/service/rt/artifacts/worklistmgmt/" xmlns:ns4="http://xmlns.oracle.com/
apps/fnd/wf/worklist/service/rt/artifacts/directoryservices/" xmlns:ns5="http://xmlns.oracle.com/apps/fnd/wf/
worklist/service/rt/artifacts/worklist/">
    <notificationdetails>
      <header>
        <region name="Custom Header">
          <view>
            <row>
              <attribute name="Description" id="0">Event Planner contract</attribute>
              <attribute name="Justification" id="1"/>
              <attribute name="Non-Recoverable Tax" id="2">0.00 USD</attribute>
              <attribute name="Requisition Total" id="3">1,000.00 USD</attribute>
            </row>
          </view>
        </region>
        <region name="Header">
          <view>
            <row>
              <attribute order="0" type="String" name="From" id="FromUser">Stock, Pat</attribute>
              <attribute order="1" type="String" name="To" id="ToUser">Brown, Casey</attribute>
              <attribute order="2" type="Date" name="Sent" id="BeginDateF">2014-04-01T05:22:17.000Z</attribute>
              <attribute order="3" type="Date" name="Due" id="DueDateF"/>
              <attribute order="7" type="String" name="ID" id="NotificationId">6275023</attribute>
            </row>
          </view>
        </region>
      </header>
      <body>
        <region id="1023" name="Requisition Lines contract" part="DETAILS"/>
        <region id="1021" name="Action History" part="HISTORY"/>
      </body>
      <result>
        <attribute type="APPROVE" name="APPROVE" id="0">Approve</attribute>
        <attribute name="APPROVE_AND_FORWARD" id="1">Approve And Forward</attribute>
        <attribute name="FORWARD" id="2">Forward</attribute>
        <attribute type="REJECT" name="REJECT" id="3">Reject</attribute>
      </result>
      <control/>
    </notificationdetails>
  </ns5:output>
</response>
```

FIG. 6D

```
<?xml version = '1.0' encoding = 'UTF-8'?>
<response status="200">
  <ns5:output xmlns="http://xmlns.oracle.com/apps/fnd/wf/worklist/service/rt/artifacts/notificationdetails/"
xmlns:ns2="http://xmlns.oracle.com/apps/fnd/wf/worklist/service/rt/artifacts/fault/" xmlns:ns3="http://
xmlns.oracle.com/apps/fnd/wf/worklist/service/rt/artifacts/worklistmgmt/" xmlns:ns4="http://xmlns.oracle.com/
apps/fnd/wf/worklist/service/rt/artifacts/directoryservices/" xmlns:ns5="http://xmlns.oracle.com/apps/fnd/wf/
worklist/service/rt/artifacts/worklist/">
    <notificationdetails>
      <body>
        <region id="1023" name="Requisition Lines contract" part="DETAILS">
          <view arrange="detail">
            <row>
              <attribute order="1" type="0" name="Line" id="Line">1</attribute>
              <attribute order="2" type="0" name="Description" id="Description">Event Planner</attribute>
              <attribute order="3" type="0" name="Supplier" id="SuggSupplier"/>
              <attribute order="4" type="0" name="Contractor Name" id="ContractorName"/>
              <attribute order="5" type="0" name="Contractor Status" id="ContractorStatus">Not Applicable</
attribute>
              <attribute order="6" type="Date" name="Start Date" id="StartDate">2014-04-02T07:00:00.000Z</
attribute>
              <attribute order="7" type="0" name="End Date" id="EndDate"/>
              <attribute order="8" type="0" name="Cost Center" id="CostCenter">740</attribute>
              <attribute order="9" type="0" name="Unit" id="Uom"/>
              <attribute order="10" type="0" name="Quantity" id="Quantity"/>
              <attribute order="11" type="0" name="Price" id="RateConsolidate"> USD</attribute>
              <attribute order="12" type="0" name="Amount" id="LineAmtConsolidate">500 USD</attribute>
            </row>
            <row>
              <attribute order="1" type="0" name="Line" id="Line">1.1</attribute>
              <attribute order="2" type="0" name="Description" id="Description">Event Planner - Expense</
attribute>
              <attribute order="3" type="0" name="Supplier" id="SuggSupplier"/>
              <attribute order="4" type="0" name="Contractor Name" id="ContractorName"/>
              <attribute order="5" type="0" name="Contractor Status" id="ContractorStatus"/>
              <attribute order="6" type="0" name="Start Date" id="StartDate"/>
              <attribute order="7" type="0" name="End Date" id="EndDate"/>
              <attribute order="8" type="0" name="Cost Center" id="CostCenter">740</attribute>
              <attribute order="9" type="0" name="Unit" id="Uom"/>
              <attribute order="10" type="0" name="Quantity" id="Quantity"/>
              <attribute order="11" type="0" name="Price" id="RateConsolidate"> USD</attribute>
              <attribute order="12" type="0" name="Amount" id="LineAmtConsolidate">500 USD</attribute>
            </row>
          </view>
        </region>
      </body>
    </notificationdetails>
  </ns5:output>
</response>
```

FIG. 7A

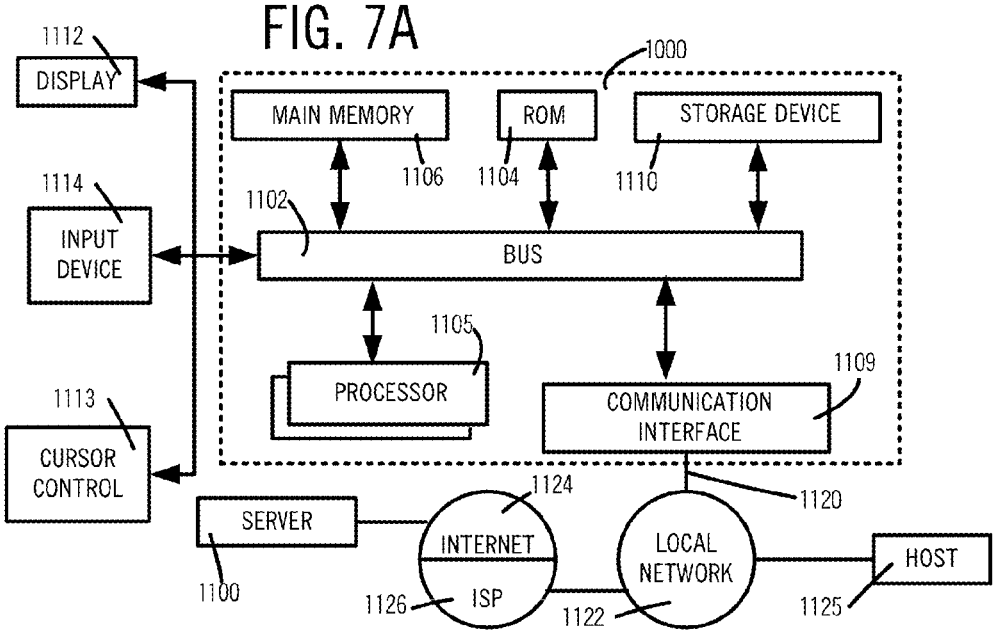

1112
DISPLAY
1000
MAIN MEMORY
ROM
STORAGE DEVICE
1106
1104
1110
1114
INPUT DEVICE
1102
BUS
1105
PROCESSOR
1109
COMMUNICATION INTERFACE
1113
CURSOR CONTROL
1124
1120
SERVER
INTERNET
LOCAL NETWORK
HOST
1100
1126
ISP
1122
1125

FIG. 7B

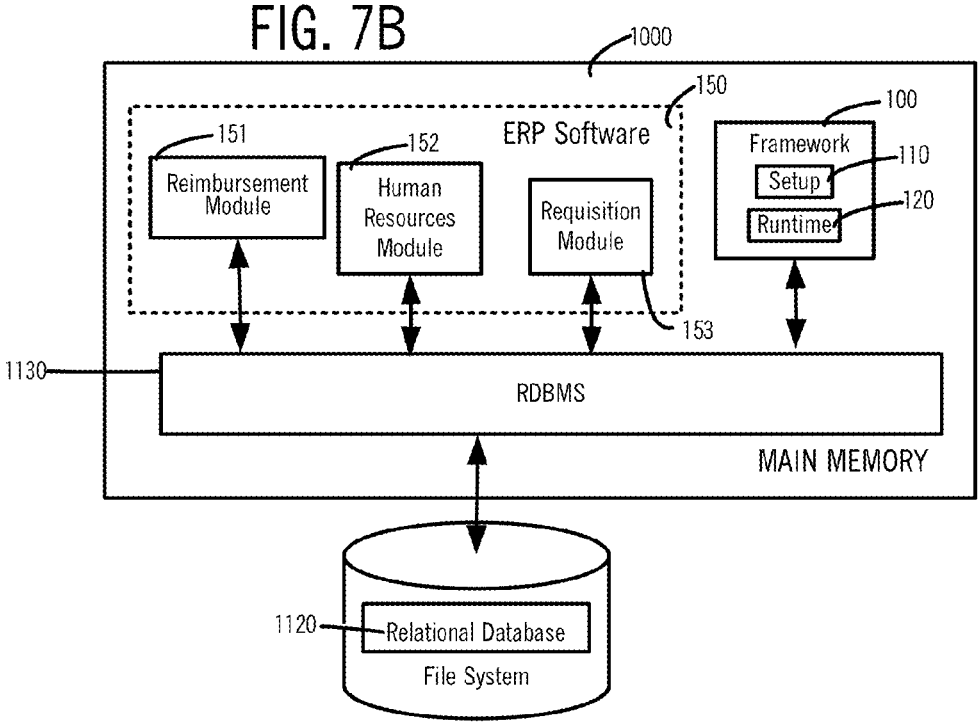

1000
150
100
151
ERP Software
152
Framework
Reimbursement Module
Human Resources Module
Requisition Module
110
Setup
120
Runtime
153
1130
RDBMS
MAIN MEMORY
1120
Relational Database
File System

FIG. 8A

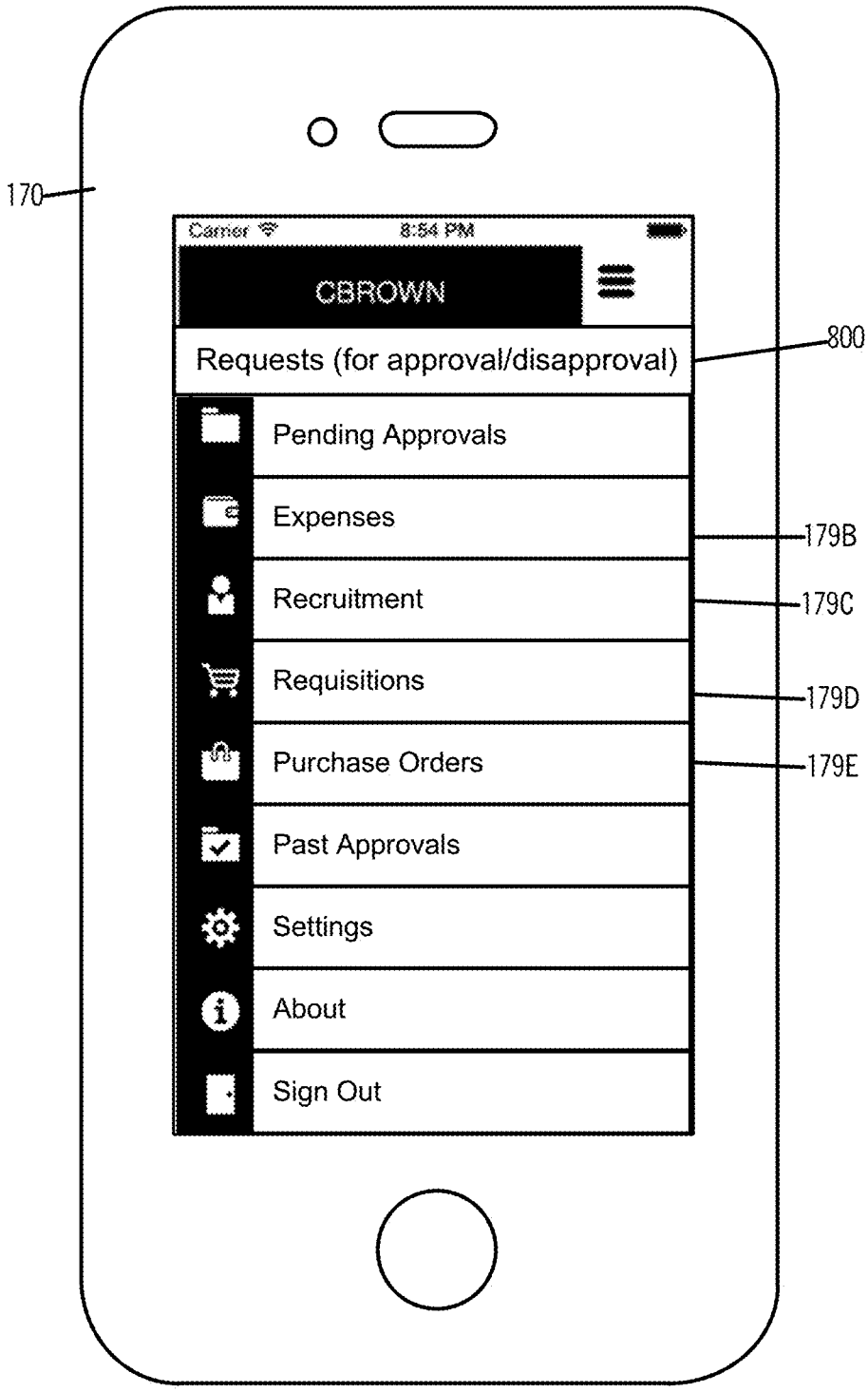

170
Carrier
8:54 PM
CBROWN
Requests (for approval/disapproval)
800
Pending Approvals
Expenses
179B
Recruitment
179C
Requisitions
179D
Purchase Orders
179E
Past Approvals
Settings
About
Sign Out

FIG. 8B

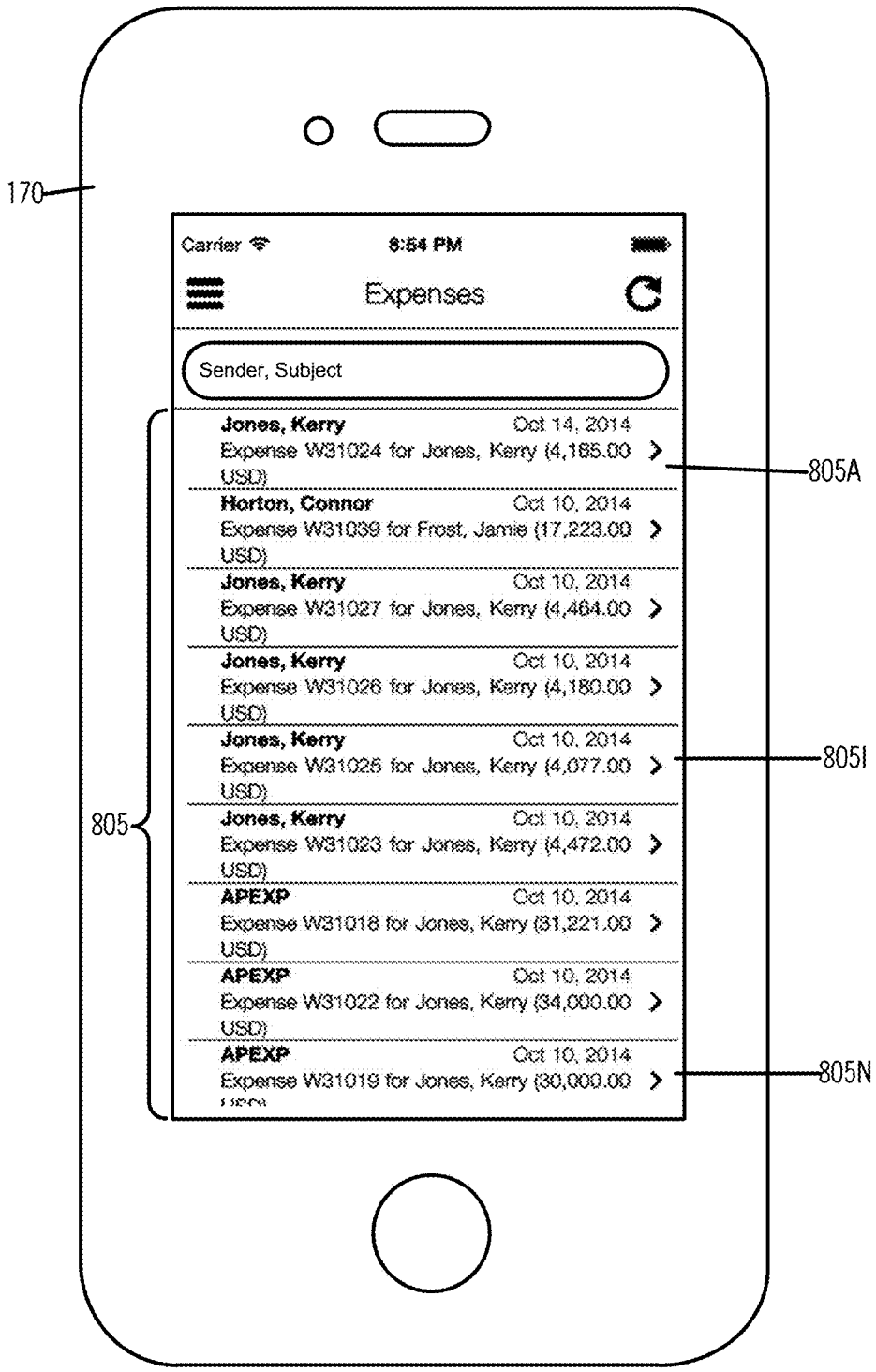

170
Carrier
8:54 PM
Expenses
Sender, Subject
Jones, Kerry Oct 14, 2014
Expense W31024 for Jones, Kerry (4,185.00 USD)
Horton, Connor Oct 10, 2014
Expense W31039 for Frost, Jamie (17,223.00 USD)
Jones, Kerry Oct 10, 2014
Expense W31027 for Jones, Kerry (4,464.00 USD)
Jones, Kerry Oct 10, 2014
Expense W31026 for Jones, Kerry (4,180.00 USD)
Jones, Kerry Oct 10, 2014
Expense W31025 for Jones, Kerry (4,077.00 USD)
Jones, Kerry Oct 10, 2014
Expense W31023 for Jones, Kerry (4,472.00 USD)
APEXP Oct 10, 2014
Expense W31018 for Jones, Kerry (31,221.00 USD)
APEXP Oct 10, 2014
Expense W31022 for Jones, Kerry (34,000.00 USD)
APEXP Oct 10, 2014
Expense W31019 for Jones, Kerry (30,000.00
805
805A
805I
805N

FIG. 8C

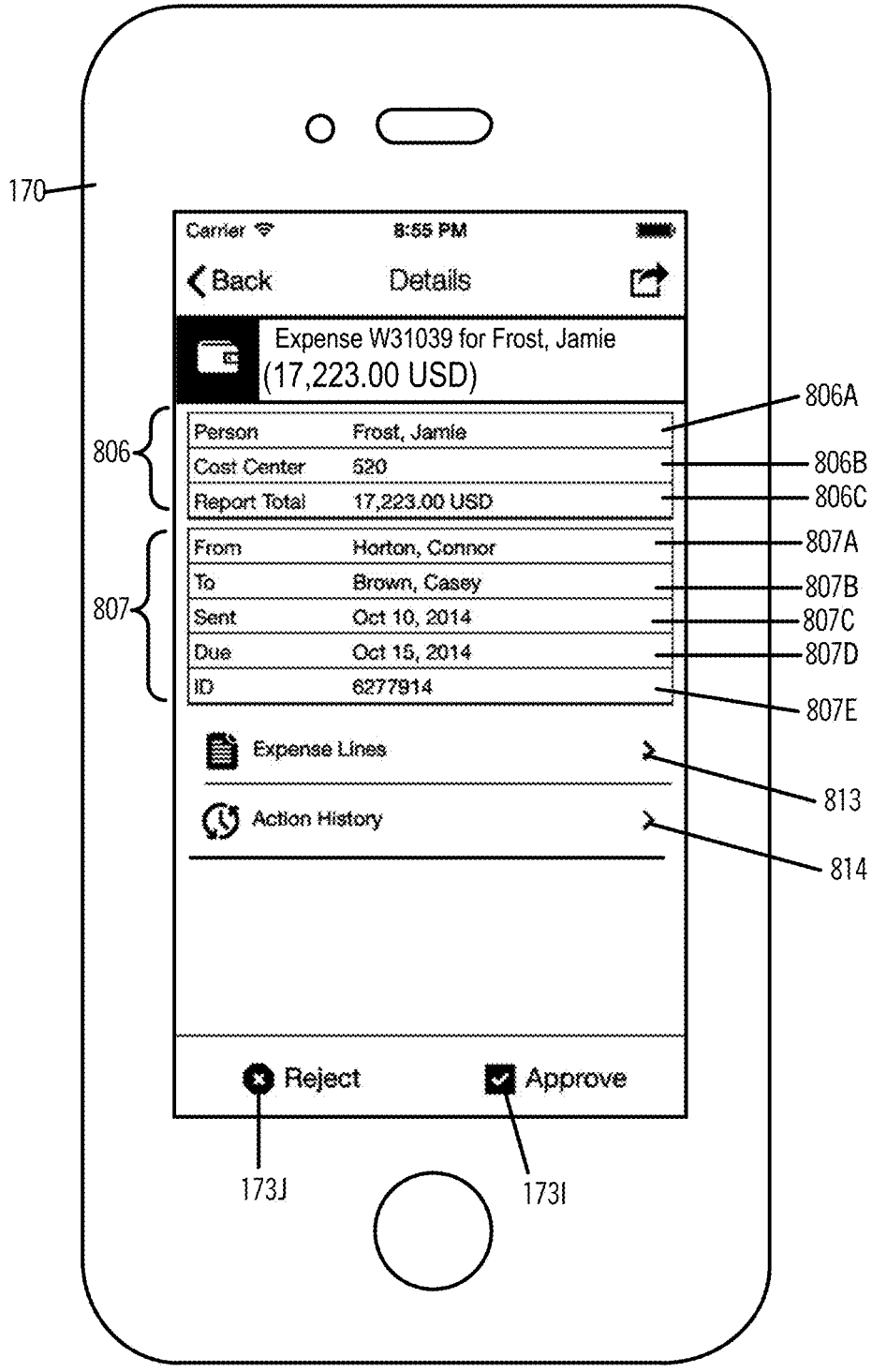

170
Carrier
8:55 PM
Back
Details
Expense W31039 for Frost, Jamie
(17,223.00 USD)
806
Person
Frost, Jamie
Cost Center
520
Report Total
17,223.00 USD
807
From
Horton, Connor
To
Brown, Casey
Sent
Oct 10, 2014
Due
Oct 15, 2014
ID
6277914
Expense Lines
Action History
Reject
Approve
806A
806B
806C
807A
807B
807C
807D
807E
813
814
173J
173I

FIG. 8D

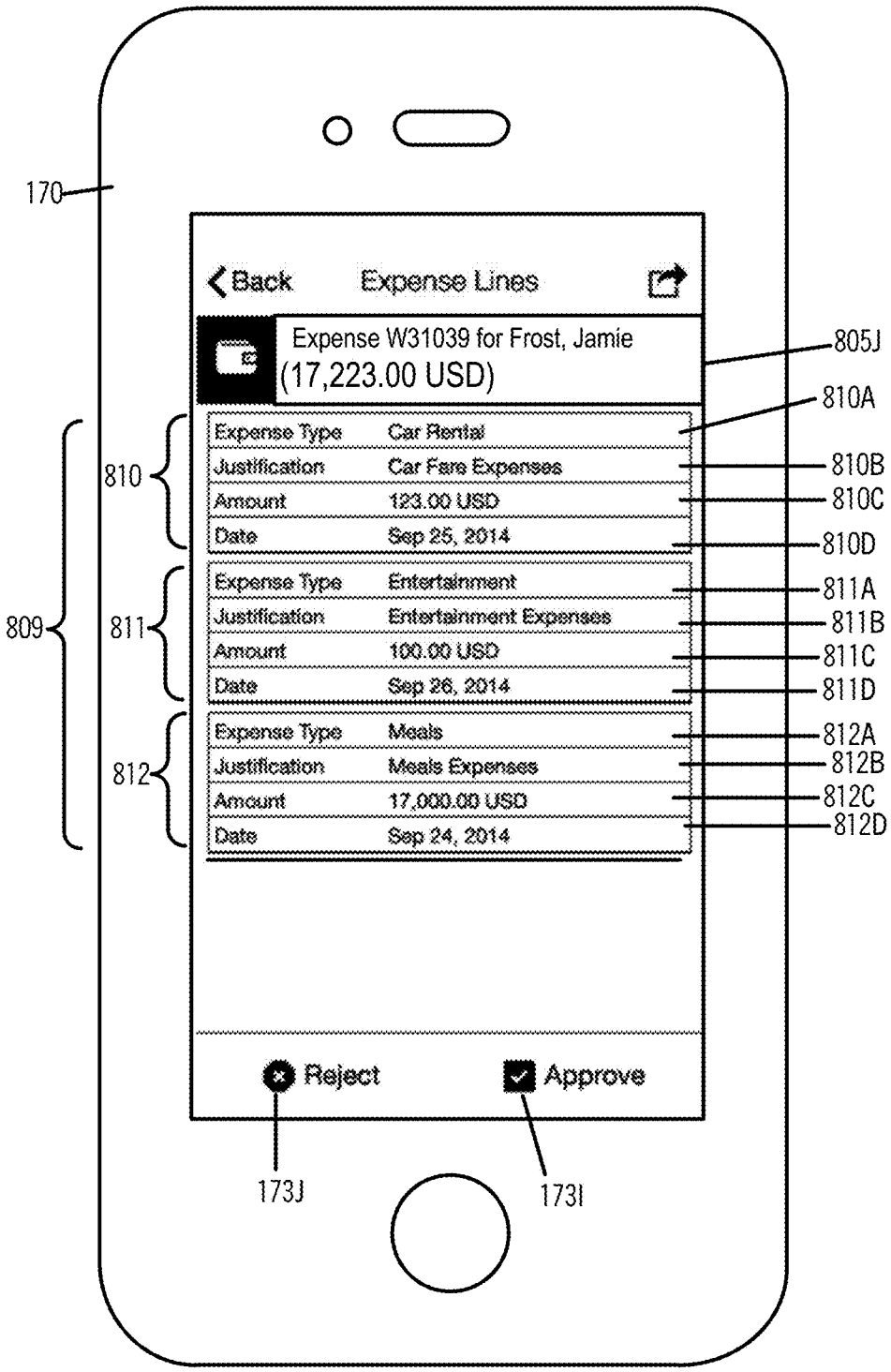

170
Back
Expense Lines
Expense W31039 for Frost, Jamie
(17,223.00 USD)
805J
810A
Expense Type Car Rental
Justification Car Fare Expenses
Amount 123.00 USD
Date Sep 25, 2014
810
810B
810C
810D
809
811
Expense Type Entertainment
Justification Entertainment Expenses
Amount 100.00 USD
Date Sep 26, 2014
811A
811B
811C
811D
812
Expense Type Meals
Justification Meals Expenses
Amount 17,000.00 USD
Date Sep 24, 2014
812A
812B
812C
812D
Reject
Approve
173J
173I

FIG. 8E

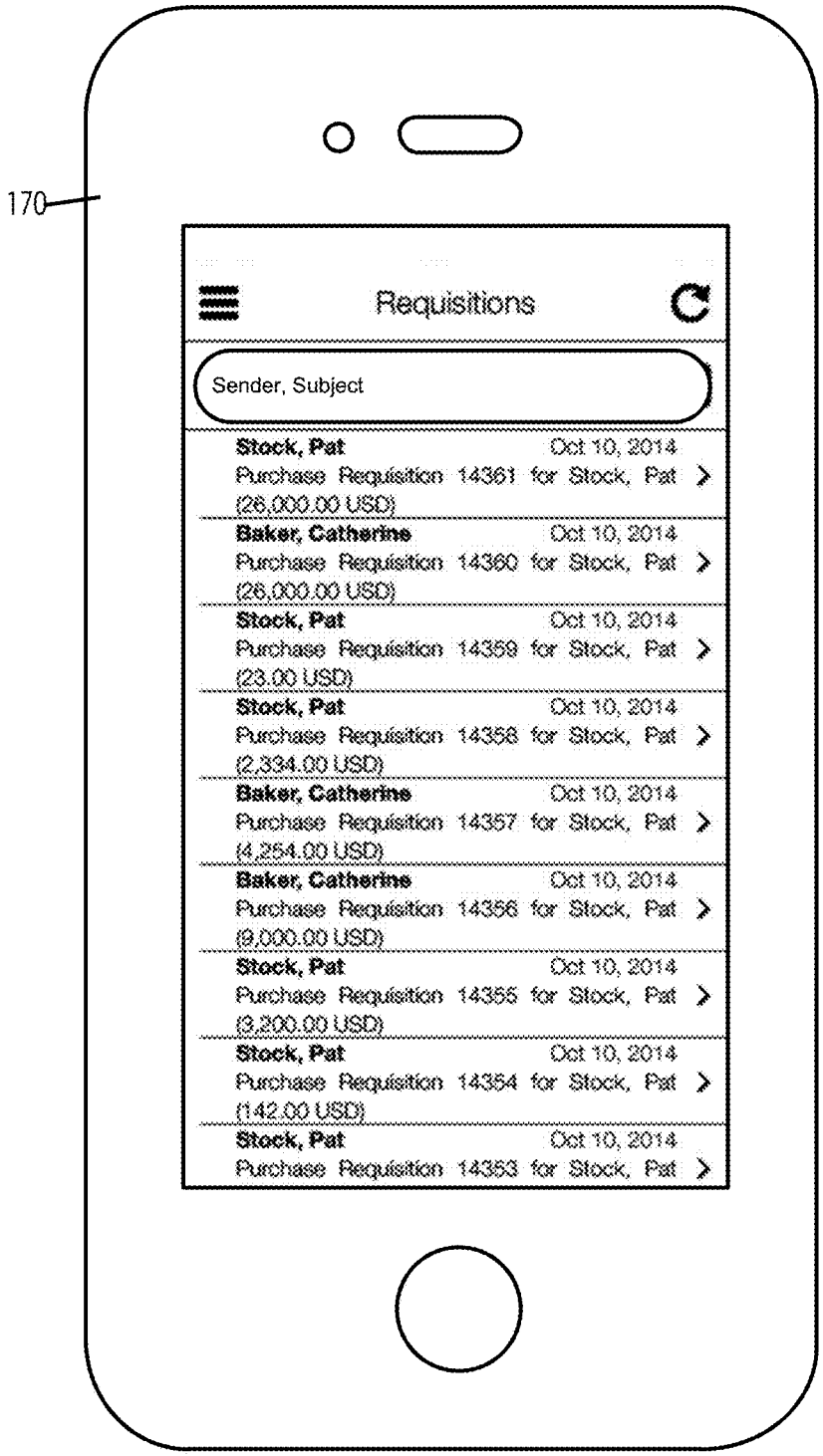

170
Requisitions
Sender, Subject
Stock, Pat Oct 10, 2014
Purchase Requisition 14361 for Stock, Pat
(26,000.00 USD)
Baker, Catherine Oct 10, 2014
Purchase Requisition 14360 for Stock, Pat
(26,000.00 USD)
Stock, Pat Oct 10, 2014
Purchase Requisition 14359 for Stock, Pat
(23.00 USD)
Stock, Pat Oct 10, 2014
Purchase Requisition 14358 for Stock, Pat
(2,334.00 USD)
Baker, Catherine Oct 10, 2014
Purchase Requisition 14357 for Stock, Pat
(4,254.00 USD)
Baker, Catherine Oct 10, 2014
Purchase Requisition 14356 for Stock, Pat
(9,000.00 USD)
Stock, Pat Oct 10, 2014
Purchase Requisition 14355 for Stock, Pat
(3,200.00 USD)
Stock, Pat Oct 10, 2014
Purchase Requisition 14354 for Stock, Pat
(142.00 USD)
Stock, Pat Oct 10, 2014
Purchase Requisition 14353 for Stock, Pat

FIG. 8F

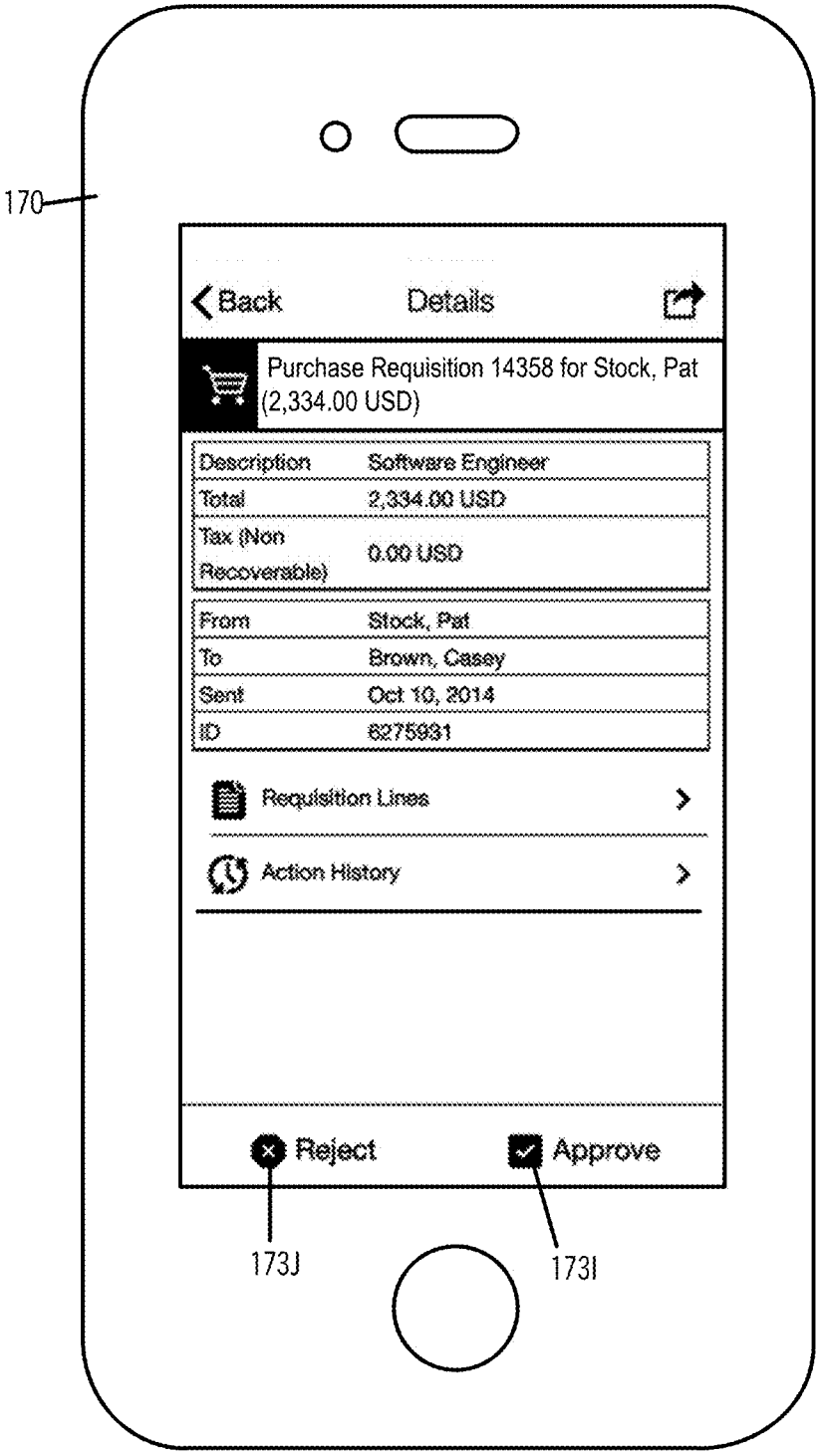

170
Back
Details
Purchase Requisition 14358 for Stock, Pat (2,334.00 USD)
Description
Software Engineer
Total
2,334.00 USD
Tax (Non Recoverable)
0.00 USD
From
Stock, Pat
To
Brown, Casey
Sent
Oct 10, 2014
ID
6275931
Requisition Lines
Action History
Reject
Approve
173J
173I

FIG. 8G

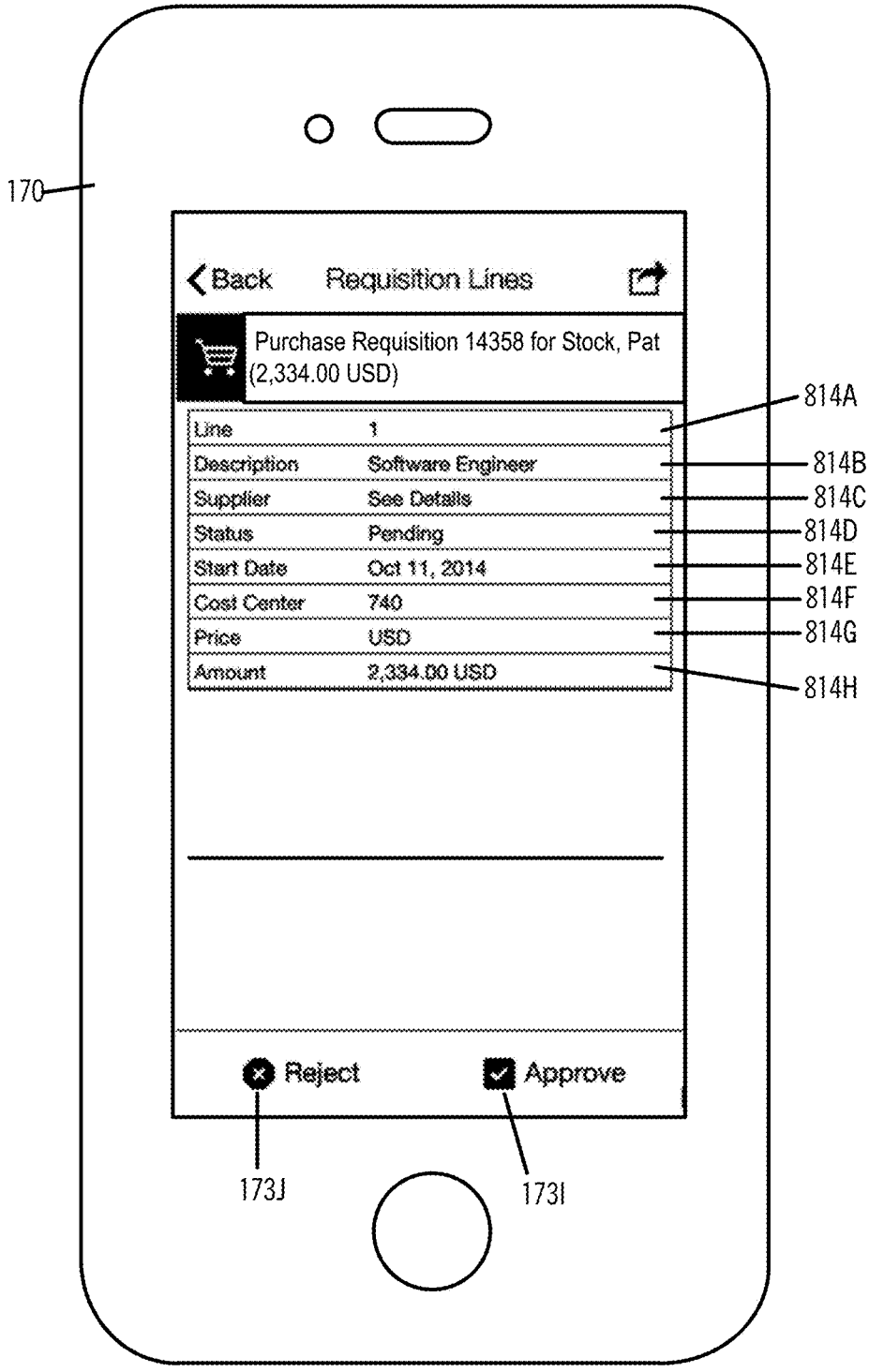

170
Back
Requisition Lines
Purchase Requisition 14358 for Stock, Pat (2,334.00 USD)
Line 1
Description Software Engineer
Supplier See Details
Status Pending
Start Date Oct 11, 2014
Cost Center 740
Price USD
Amount 2,334.00 USD
814A
814B
814C
814D
814E
814F
814G
814H
Reject
Approve
173J
173I

FIG. 8H

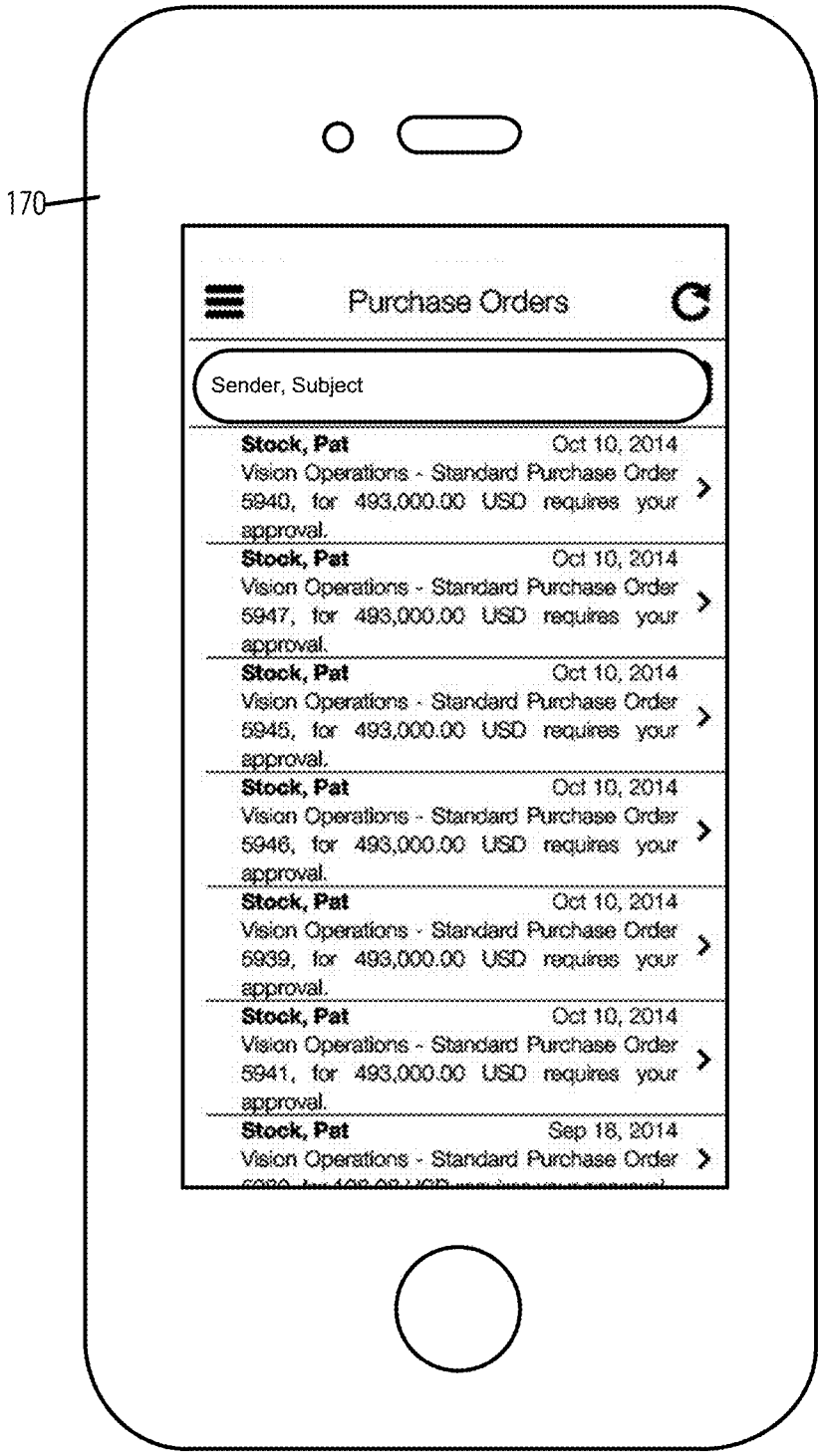

170
Purchase Orders
Sender, Subject
Stock, Pat Oct 10, 2014
Vision Operations - Standard Purchase Order 5940, for 493,000.00 USD requires your approval.
Stock, Pat Oct 10, 2014
Vision Operations - Standard Purchase Order 5947, for 493,000.00 USD requires your approval.
Stock, Pat Oct 10, 2014
Vision Operations - Standard Purchase Order 5945, for 493,000.00 USD requires your approval.
Stock, Pat Oct 10, 2014
Vision Operations - Standard Purchase Order 5946, for 493,000.00 USD requires your approval.
Stock, Pat Oct 10, 2014
Vision Operations - Standard Purchase Order 5939, for 493,000.00 USD requires your approval.
Stock, Pat Oct 10, 2014
Vision Operations - Standard Purchase Order 5941, for 493,000.00 USD requires your approval.
Stock, Pat Sep 18, 2014
Vision Operations - Standard Purchase Order

FIG. 8I

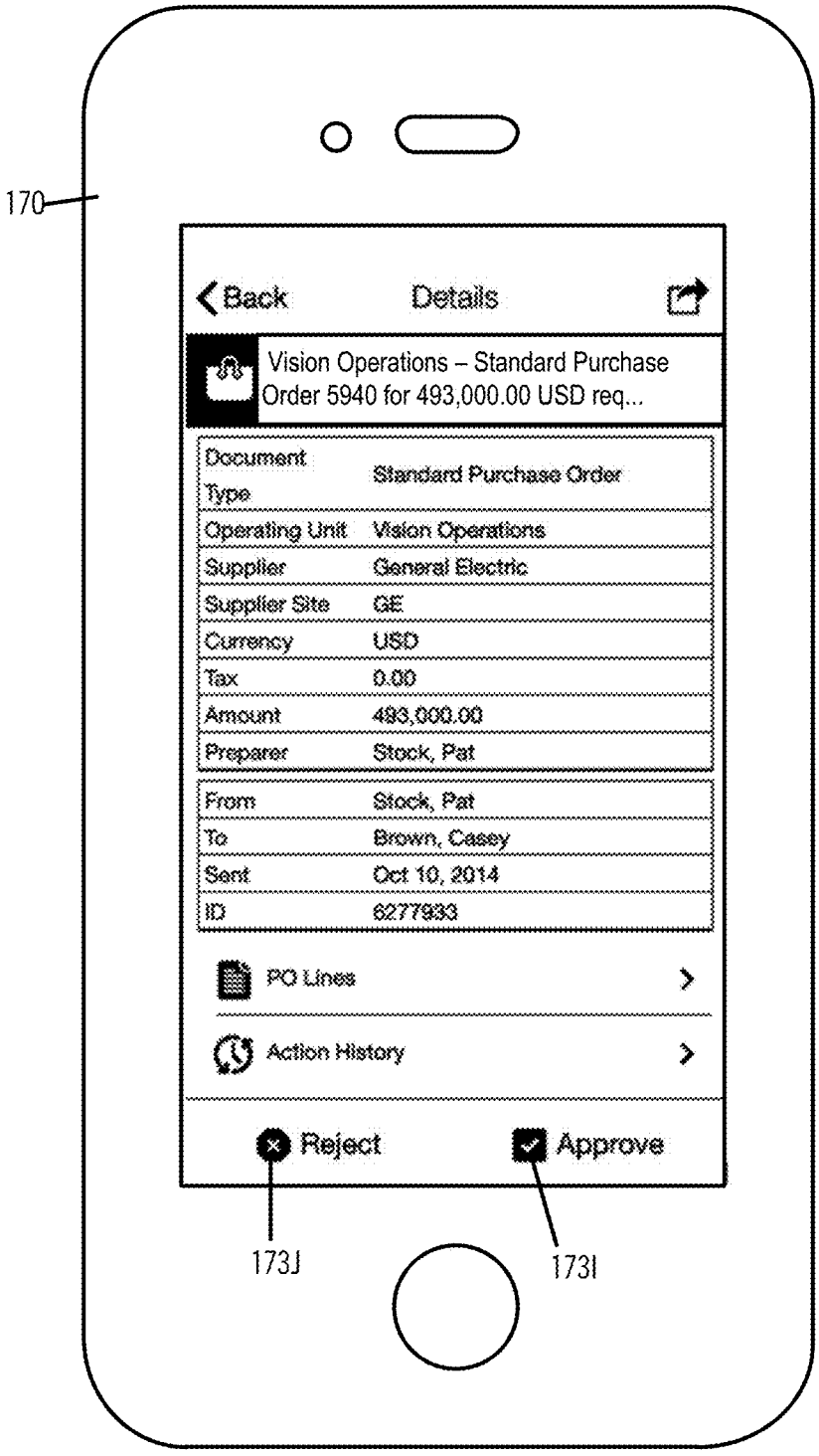
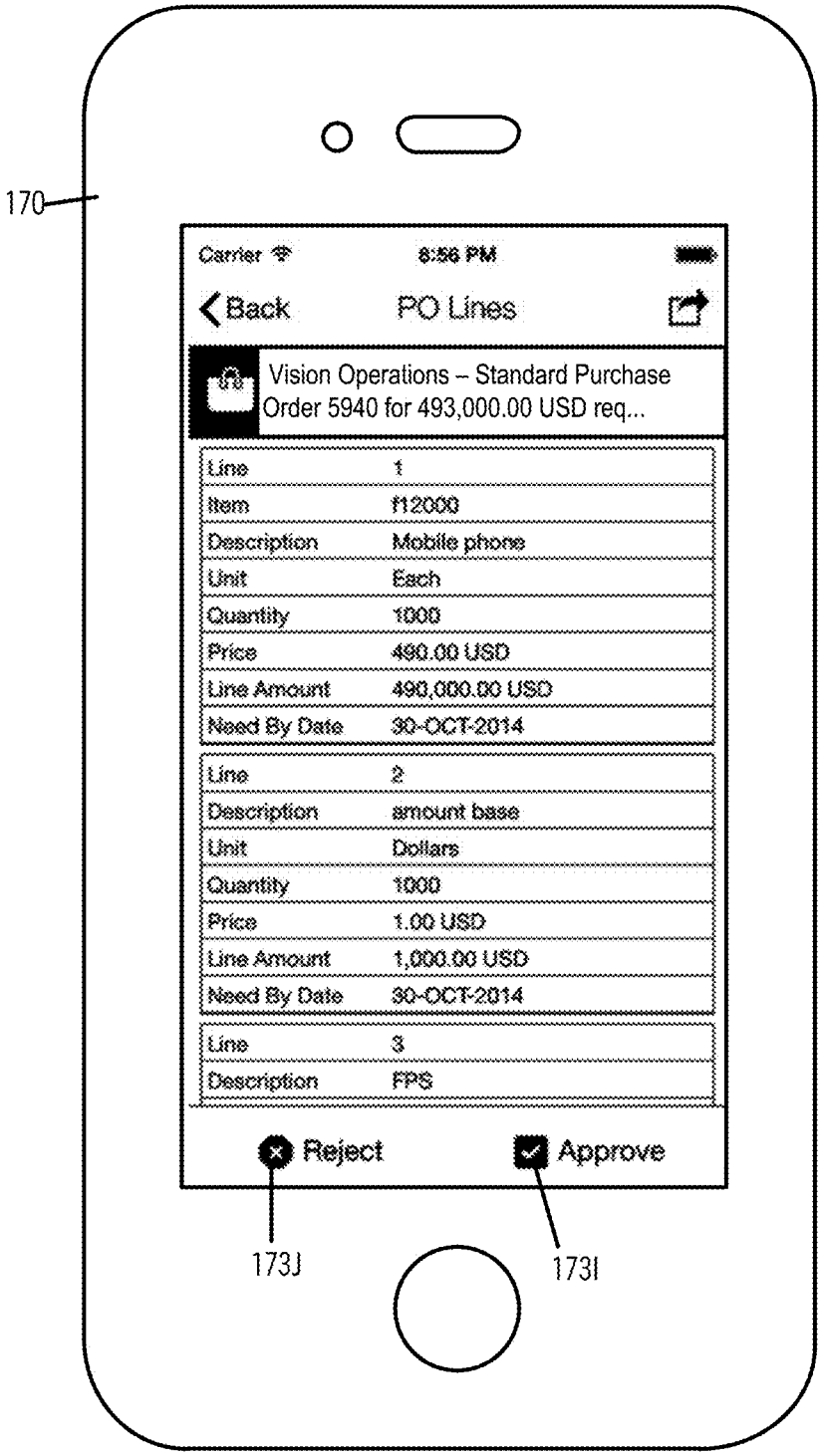

170
Back
Details
Vision Operations – Standard Purchase Order 5940 for 493,000.00 USD req...
Document Type
Standard Purchase Order
Operating Unit
Vision Operations
Supplier
General Electric
Supplier Site
GE
Currency
USD
Tax
0.00
Amount
493,000.00
Preparer
Stock, Pat
From
Stock, Pat
To
Brown, Casey
Sent
Oct 10, 2014
ID
6277933
PO Lines
Action History
Reject
Approve
173J
173I

FIG. 8J


170
Carrier
8:56 PM
Back
PO Lines
Vision Operations – Standard Purchase Order 5940 for 493,000.00 USD req...
Line 1
Item f12000
Description Mobile phone
Unit Each
Quantity 1000
Price 490.00 USD
Line Amount 490,000.00 USD
Need By Date 30-OCT-2014
Line 2
Description amount base
Unit Dollars
Quantity 1000
Price 1.00 USD
Line Amount 1,000.00 USD
Need By Date 30-OCT-2014
Line 3
Description FPS
Reject
Approve
173J
173I

CONFIGURATION-BASED PROCESSING OF REQUESTS BY CONDITIONAL EXECUTION OF SOFTWARE CODE TO RENDER REGIONS IN A DISPLAY

CROSS-REFERENCE TO PROVISIONAL APPLICATION

This patent application claims priority under 35 USC §119 from U.S. Provisional Application 62/011,017 entitled "CONFIGURATION-BASED PROCESSING OF WORK ITEMS BY CONDITIONAL EXECUTION OF SOFTWARE CODE" filed on Jun. 11, 2014 by Vijayakumar Shanmugam, Sudipto Chakraborty and Dilbaghsingh Sardar, which is hereby incorporated by reference herein in its entirety.

FIELD

This patent application relates to apparatuses, methods and non-transitory computer-readable storage media for processing of requests for user input which are normally used to obtain responses of approval (or disapproval) from users.

BACKGROUND

Client devices ("clients"), such as a desktop computer or a handheld wireless device may execute software instructions in the form of application programs (also called "client apps") that are used by a manager to approve of one or more requests related to work ("work items") in an organization. Examples of work items are requests typically submitted by employees, such as requests for requisition and/or requests for reimbursement of out-of-pocket expenses. Work items typically have one or more attributes, such as amount, due date, description, etc., which may be entered by the employee and displayed to the manager by a client app, in order to obtain the manager's approval (or disapproval) of the work item.

Client apps obtain work items to display to a manager from programs executing in servers that implement business logic (also called "business applications"). Each business application typically provides its own interface, and hence it is common for a specific client app to be designed to retrieve and display work items generated by a corresponding business application. In such systems, a client app designed for one business application cannot retrieve and display work items from another business application. Thus, multiple client apps may be used by a manager, to review and approve work items in multiple business applications.

It is more efficient for a manager to use a single client app to access work items in multiple business applications. Due to existence of multiple interfaces of multiple business applications, creation of the single client app requires re-creation of software instructions that exist in the multiple client apps. Hence, there is a need for apparatuses, methods and non-transitory computer-readable storage media as follows.

SUMMARY

In accordance with the invention, one or more computers (e.g. in which applications are deployed, also called "servers") process requests to obtain user input (e.g. work items), by conditionally including, within the requests, one or more regions (also called "groups of line items"), based on rules.

The rules are configurable, and each rule is associated with an identifier of a software code (also called software code identifier) to be executed to render a region (or group of one or more line items) when the rule is satisfied. The rule and the software code identifier together form a pair ("rule action" pair), which corresponds to one region (or line item group) that is includable in a request (e.g. work item).

During setup, servers (also called "second computers") receive one or more selections from one or more clients that are used by one or more developers (also called "first computers") via one or more screens for a template to be used to instantiate each request (e.g. work item). The received selection(s) identify each region (or line item group) that is includable in each request (e.g., work item). For each such region, the selection(s) further identify and a corresponding rule action pair.

During runtime, on receipt of a message identifying a request (or work item), the one or more servers (or second computers) evaluate the one or more rules corresponding to regions (or line item groups) that are includable in an identified request (e.g., work item). The evaluation is performed to identify one or more regions (or line item groups) which are to be rendered (when their corresponding rule is satisfied). For a to-be-rendered region (or line item group), the one or more servers (or second computers) execute a specific software code identified in the rule action pair. The execution is performed to obtain one or more rows of data on the region (or line item group). Each such row of data ("first row", or "data row") may include multiple name value pairs.

The first row(s) of data that are output by execution of the specific software code in one or more servers (or second computers) may be retrieved from a relational database that may store corresponding rows (which are returned by execution of a database query). Hence, in such embodiments, each first row may include multiple name value pairs. The names (which identify attributes of a request) in the multiple name value pairs may be implemented as columns in one or more tables of the relational database.

The one or more servers (or first computers) transmit the multiple name value pairs (or details) of a first row ("data row") output by the specific software code to a mobile device as multiple lines ("display lines") in content of the request (e.g. work item), with or without a header (depending on the embodiment). The transmission is performed to obtain user input indicative of at least one of approval or disapproval of the request (e.g. work item). Each name value pair is included in a single line ("display line") among multiple lines of a row in the request ("second row", or "display row"). Multiple lines ("display lines") within a second row (which correspondingly contain the multiple name value pairs), are sequenced relative to one another in a specific sequence to be displayed by the mobile device. The specific sequence is received as user input, from one or more developer(s) who operate the one or more clients (or first computers).

It is to be understood that several other aspects of the described embodiments will become readily apparent to those skilled in the art from the description herein, wherein it is shown and described various aspects by way of illustration. The drawings and detailed description below are to be regarded as illustrative in nature and not as restrictive.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1A** illustrates, in a flow chart, acts performed to configure generation of requests to obtain user input indica-

tive of at least one of approval or disapproval, in some illustrative embodiments in accordance with the invention.

FIG. **1**B illustrates, in a flow chart, acts performed at run time to generate requests to obtain user input indicative of at least one of approval or disapproval, in some illustrative embodiments in accordance with the invention.

FIG. **1**C illustrates, in a data flow diagram, configuration-based processing of work items by use of a framework in certain embodiments in accordance with the invention, by a developer supplying configuration information including identifiers of line items (also called "line item identifiers") that are includable in a work item, and a pair formed by a rule and an identifier of a software code (also called "software code identifier") to be executed to render one or more includable line item(s) in the work item when the rule is satisfied.

FIGS. **1**D and **1**E illustrate a mobile device **170** of FIG. **1**C configured to display a work item's header and content respectively.

FIG. **1**F illustrates, in a data flow diagram similar to FIG. **1**C, configuration of a framework that supports use of a mobile device **167** configured for use by a developer, and further supports use of another mobile device **189** configured for use by an employee in additional embodiments also in accordance with the invention.

FIG. **2** illustrates, in a flow chart, acts performed in set up operation **130** in the framework of FIGS. **1**C and **1**F to receive and store configuration information and acts performed in runtime operation **140** to use the stored configuration information to process work items in some illustrative embodiments in accordance with the invention.

FIGS. **3**A-**3**H illustrate screens generated by one or more computers **200** of FIG. **2** executing setup operation **130** of framework **100** in certain illustrative embodiments.

FIG. **4**A-**4**C illustrate, in flow charts, acts performed by one or more computers **200** by use of one or more processors programmed with a sequence of instructions of software stored in one or more memories, to implement setup operation **130** of framework **100** in exemplary embodiments in accordance with the invention.

FIG. **5**A-**5**D illustrate, in flow charts, acts performed by one or more computers **200** by use of one or more processors programmed with a sequence of instructions of software stored in one or more memories, to implement runtime operation **140** of framework **100** in exemplary embodiments in accordance with the invention.

FIGS. **6**A-**6**D illustrate output generated by runtime operation **140** of framework **100** by performance of the acts illustrated in FIGS. **5**A-**5**D.

FIGS. **7**A and **7**B illustrate, in block diagrams, hardware and software portions of one or more computers **200** that perform one or more acts illustrated in FIG. **2** and in FIGS. **4**A-**4**C and **5**A-**5**D in some embodiments.

FIGS. **8**A-**8**J illustrate displays that are rendered by mobile device **170** of some embodiments.

DETAILED DESCRIPTION

In illustrative embodiments, one or more computers **200** (also called "servers") may be programmed with software **100** (called "framework") that includes a setup operation **130** and a runtime operation **140** as shown in FIGS. **1**A and **1**B, as follows. Specifically, in a setup operation **130**, the computer(s) perform acts **101**-**109** as shown in FIG. **1**A, to configure generation of requests to obtain user input indicative of at least one of approval or disapproval, e.g. by preparing and transmitting screens to receive selections from one or more computers operated by human(s) (e.g. developers). Thereafter, in a runtime operation **140**, the computer(s) perform acts **141**-**149** as shown in FIG. **1**B, to generate requests and receive user input thereon, e.g. by preparing and transmitting requests to receive the user input from one or more mobile devices operated by other human(s) (e.g. approvers). Although acts **101**-**109** are described below, and illustrated in FIG. **1**A in a first sequence ("setup sequence"), they may be performed in any other sequence relative to one another. Similarly, acts **141**-**149** are described below, and illustrated in FIG. **1**B in a second sequence ("runtime sequence"), they may be performed in any other sequence relative to one another. Acts **101**-**109** of the setup sequence are normally performed before acts **141**-**149** of the runtime sequence.

More specifically, in an act **101** (FIG. **1**A), computer(s) **200** prepare and transmit one or more screen(s) to receive search criteria to identify templates of requests. For example, screen **301** illustrated in FIG. **3**A enables receipt of search criteria in the form of a type of requests (e.g. workflow name **351**) and/or template name (e.g. field **352**). Thereafter, in act **102** (FIG. **1**A), computer(s) **200** prepare and transmit a list of names of templates (e.g. list **161** in FIGS. **1**C and **1**F, list **302** in FIG. **3**A) of request. Subsequently, in act **103** (which may be similar or identical to act **231** described below in reference to FIG. **2**), computer(s) **200** receive a selected name of a request template, e.g. identifier of a request **162** (FIGS. **1**C, **1**F), name **302**A (FIG. **3**A).

Thereafter, to enable configuration of the selected request, in act **104** (FIG. **1**A), computer(s) **200** prepare and transmit one or more screen(s) (e.g. screen **162**A in FIG. **1**F, screen **305** in FIG. **3**B) to receive selections identifying names of attributes (e.g. names #HDR_1, and #HDR_3 in FIG. **3**B) that are selected (e.g. by a developer) from a larger plurality of names (e.g. see group **306** in FIG. **3**B). The larger plurality of attribute names includable in a request header are extracted from columns of one or more tables of a relational database, e.g. tables **236** described below. Selections made in the just-described screen(s), e.g. screen **305**, are received in computer(s) **200** e.g. as attribute identifiers **162**B in FIG. **1**F, and stored in configuration information e.g. in configuration tables **1120** (FIG. **1**F) of the relational database, for subsequent use in runtime operation **140** in generating a header of the request being configured in operation **130** (FIG. **1**A).

Thereafter, in act **105** (which may be similar or identical to act **233** described below), computer(s) **200** prepare and transmit one or more screen(s) (e.g. screen **163** in FIGS. **1**C and **1**F, screen **308** in FIG. **3**C) to receive a set of identifiers (also called "region identifiers") of one or more regions (also called line item groups) that are includable in a content of the request. Configuration information received via the just-described screen(s), e.g. screen **308** (FIG. **3**C), is received in computer(s) **200** e.g. as region identifiers **164** shown in FIGS. **1**C, **1**F and stored, e.g. in the relational database, for subsequent use in runtime operation **140** in generating content of the request being configured in operation **130**.

Thereafter, an act **106** (FIG. **1**A) is repeatedly performed, for each includable region identified in act **105** (described above), e.g. similar or identical to act **234** described below. Specifically, in act **106** (FIG. **1**A), computer(s) **200** receive information on a rule action pair corresponding to each includable region, wherein the rule action pair information comprises a definition of a rule and an identifier of a specific software code (or software code identifier) to be executed

when the rule is satisfied. Rule action pairs may be identified in act **106** e.g. as described below in reference to buttons **313**A and **314**A, shown in a single row (also called "display row") for a region (or line item group) **310**A (FIG. **3**C). Information on a rule action pair is received in computer(s) **200** for each includable region, and stored in configuration information, e.g. in the relational database, for subsequent use in runtime operation **140** in generating content of the request being configured in operation **130**.

Act **106** may include an act **107** that is repeatedly performed for each rule, wherein computer(s) **200** prepare and transmit one or more screen(s) (e.g. see subscreen **315** in FIG. **3**D) to receive for each rule in a rule action pair being identified in act **106** (FIG. **1**A), a definition of the rule which includes user input on selections identifying an operator, a type of operand, an operand and a constant, e.g. as described below. Furthermore, act **106** may also include a group of acts **108**A-**108**C that are repeatedly performed for each action in a rule action pair, wherein computer(s) **200** prepare and transmit one or more screen(s) to obtain information needed to perform the action.

Specifically, in act **108**A, computer(s) **200** may prepare and transmit screen(s) to receive, for each action in a rule action pair, selections identifying an application module, an object within the application module, and to receive as the identifier of the specific software code, a method (also called "action programmatic method", or simply "programmatic method") **320**B within the object **320**D, as illustrated by screen **317** shown in FIG. **3**E, described below. Moreover, in act **108**B, computer(s) **200** may prepare and transmit screen(s) to receive, a mapping between input parameters of a specific software code (e.g. identified in act **108**A), and attributes of the request, e.g. as illustrated by table **323** shown in FIG. **3**H, described below.

Furthermore, in act **108**C, computer(s) **200** may prepare and transmit screen(s) to receive selections identifying names of attributes that are selected from a larger plurality of names of attributes output by an action programmatic method, and thus available for inclusion in content of a region in the request being configured (in a manner similar to attribute names selected for inclusion in the request's header, as described above in reference to act **104**). Screens of act **108**C used for selection of attribute names may be e.g. as illustrated in FIG. **3**F (described below). In act **108**C, the larger plurality of names may also be extracted from columns one or more tables of the relational database and/or based on output attributes of the specific software code identified in act **108**A. Also in act **108**C, computer(s) **200** may receive a specific sequence of the names selected for inclusion in the request's content (also identified in act **108**C), e.g. as illustrated in column **323**C in FIG. **3**F and the sequence may be changed as described below in reference to FIG. **3**G and button **319**.

Act **107** for each rule and the group of acts **108**A-**108**C for each action may be performed in any sequence relative to one another, so long as each rule and each action is specified in each rule action pair received in act **106**. Note that a single action may be used in common with multiple rules, e.g. depending on the rule action pairs of the request being configured.

Before, during, or after act **106** (depending on selection by a developer), an act **109** (FIG. **1**A) may be performed by computer(s) **200** to receive another sequence, in which two or more rules are to be evaluated, relative to one another, e.g. when multiple rule action pairs are defined in act **106**, for the content of a single request. For example see sequence numbers **312**A, **312**B in FIG. **3**C, described below.

Acts **101**-**109** (FIG. **1**A) enable developers to declaratively implement different types of requests, by configuration in operation **130**, following which runtime operation **140** performs one or more of acts **141**-**149** (FIG. **1**B) to automatically generate requests of these different types, e.g. in response to messages from mobile device **170**. Specifically, in act **141**, computer(s) **200** may receive from a mobile device (e.g. mobile device **170** in FIG. **1**C), a message that identifies a type of requests. The just-described request type identifies one or more templates that are used by a module in application software, to obtain and store in table(s) of a relational database, data related to requests transmitted to the module by computer(s) and/or mobile devices operated by humans (e.g. requesters). The just-described data related to requests is used by computer(s) **200** in runtime operation **140** to prepare header and/or content of requests, and to receive user input on each request indicative of at least one of approval or disapproval. The just-described data related to requests may be received by modules in application software in any manner, e.g. as user input received from requesters, followed by the modules storing in table(s) of the relational database, the just-described data and/or data derived therefrom (e.g. by execution of software code in the modules).

Accordingly, in act **142**, computer(s) **200** retrieve from one or more database tables, information on requests that are instantiated by the module(s), based on a template that is at least partially identified by the request type (e.g. by request type (or workflow name) **351** in FIG. **3**A). Specifically, in some embodiments, a request type (e.g. workflow name) of "Requisition" may completely identify a single request template such as the template of name **302**A (e.g. labeled as "Approve Requisition" in FIG. **3**A). However, in other embodiments a request type only partially identifies request templates, and in these embodiments multiple request templates are retrieved in act **142** (e.g. templates identified in list **302** which are named "Approve Requisition", "Requisition Approval Reminder", "Unable to Reserve CLM" and "Document Manager Failed" as shown in FIG. **3**A). Thereafter, in act **143**, computer(s) **200** prepare and transmit to mobile device **170**, a summary (e.g. a list) of requests that are instantiated in the relational database, and identified based on the request type. Examples of request summaries are illustrated in (a) FIG. **8**B for expense requests, (b) FIG. **8**E for requisition requests, and (c) FIG. **8**H for purchase order requests.

Thereafter, in act **144**, computer(s) **200** receive from mobile device **170**, a message that identifies a specific request in the summary (e.g. list). Then, in act **145**, computer(s) **200** evaluate at least one rule in a rule action pair corresponding to at least one includable region identified in a set of region identifiers(s). The set of region identifiers are retrieved from configuration information, which may be e.g. retrieved from the relational database based on a template used to generate the request. When one or more evaluated rule(s) is/are found to be satisfied, one or more region(s) corresponding thereto are identified in computer(s) **200**, as being renderable, in displaying the specific request.

In certain configurations ("first" configurations), there is only one rule ("first rule") that corresponds to a region ("first region") of a request, and there is only one region ("first region") that is identified for the request (in the set of regions), and this region ("first region") is identified as renderable when the rule ("first rule") is found to be satisfied. In other configuration ("second" configuration), multiple rules ("second rules") are configured for a single region ("second region") of a request, and there is only one region

("second region") identified for the request (in the set of regions), and this region ("second region") is identified as renderable, when any one of the multiple rules ("second rule") is found to be satisfied. In still other configurations ("third" configurations), several rules (Ni "third rules") are configured for each region i (i-th "third region") of a request, and there are multiple regions (e.g. 0<i<m "third regions") identified for the request (in the set of regions). In the third configurations, when any one of the third rules (e.g. one of Nj third rules) is satisfied for a specific third region (e.g. j-th third region), that specific third region (e.g. the j-th third region) is identified as being renderable In the third configurations, more than one region (e.g. i-th and j-th regions) may be identified as being renderable, when a corresponding rule is found to be satisfied (e.g. one of the Ni third rules is found to be satisfied, and one of the Nj third rules is also found to be satisfied).

Accordingly, for each to-be-rendered region identified in act **145**, computer(s) **200** perform acts **146** and **147**, as follows. In act **146**, computer(s) **200** execute at least a specific software code that is identified in configuration information, in a rule action pair corresponding to the to-be-rendered region identified by evaluation (in act **145**). The specific software code, on execution, returns one or more rows ("first rows", or "data rows"), each row including multiple name value pairs. In embodiments wherein the first rows are retrieved from a relational database, the names in the multiple name value pairs are implemented as columns in one or more tables of the relational database.

Thereafter, in act **147**, computer(s) **200** prepare at least a portion of content of the specific request identified in act **144**, by formatting the multiple name value pairs that were identified in act **146** into corresponding multiple lines ("display lines") in a row ("second row", or "display rows") of a to-be-rendered region identified in act **145**. In the just-described multiple display lines, each name value pair among the multiple name value pairs is included in a single display line of the to-be-rendered region. As noted in the last sentence of the previous paragraph, the just-described multiple name value pairs may be received in a single data row, corresponding to multiple columns in a database table, from which the multiple name value pairs are extracted. The number of second rows ("display rows") which are prepared, for a single to-be-rendered region in act **147**, depends on a corresponding number of first rows ("data rows") that are returned by execution of the specific software code (which in turn may correspond to, e.g. rows (also called "database rows") returned by execution of a database query). Moreover, for use in display by mobile device **170**, multiple lines ("display lines") within each row ("display row") of the to-be-rendered region are sequenced relative to one another, in a specific sequence that was received as user input from one or more developers, e.g. in act **108**C of setup operation **130**. For example, see the "attribute order" with sequence numbers **1-8**, in the corresponding eight display lines, such as lines **814**A-**814**H in FIG. **8**G (in turn corresponding to eight XML statements **601**A-**601**H, starting with the XML tag <attribute . . . > and ending with the XML tag </attribute>, all within a single display row **601** in FIG. **6**B), whereby the eight display lines **814**A-**814**H are sequenced relative to one another in the specific sequence, which is received during setup operation **130** as user input from a developer, as shown in FIG. **3**F.

After content for each to-be-rendered region has been generated (by performing acts **146** and **147**, and repetition thereof if necessary), computer(s) **200** transmit to the mobile device **170**, a header and content of the specific request identified in act **144**, followed by act **149** in which user input is received and stored, e.g. in the relational database. Thereafter, computer(s) **200** may return to act **144** (described above).

In several aspects of described embodiments, one or more computers **200** process a request **177** (FIG. **1**C) by assembling content to be rendered therein. Request **177** is typically created by a software application **150** (FIG. **1**C) in the one or more computer(s) **200** each of which may be implemented as computer **1000** including one or more hardware components as illustrated in FIG. **7**A and/or software components illustrated in FIG. **7**B and discussed below. Request **177** is typically created by application module(s) **151**, **152** (FIG. **2**) of software application **150** in computer(s) **200** in response to user input received by client computer(s) **182**, **186** (FIG. **1**C), e.g. from requester(s) **181**, **185**. For example, requester **181** may use a desktop computer **182** to create a request **183** (FIG. **1**C), e.g. for reimbursement of expenses by use of a reimbursement module **151** which is a business application in enterprise resource planning (ERP) software **150** executed in one or more computers **200**.

Similarly, requester **185** may use a desktop computer **186** to create another request **187** (FIG. **1**C), e.g. for making a requisition, by use of a requisition module **153** in ERP software **150** (implementing an application of some embodiments). Requests **183** and **187** may be created via browsers (such as INTERNET EXPLORER or FIREFOX) in computers **182** and **186** that display screens (not shown) generated by corresponding modules **151** and **152** of software application **150**, in the normal manner. Each of computers **182** and **186** may be implemented as computer **1000** including one or more hardware components as illustrated in FIG. **7**A and/or software components illustrated in FIG. **7**B and discussed below.

Requests **183** and **187** are stored by execution of software application **150** in a relational database **1120** as data in corresponding rows ("database rows") in one or more tables, such as one database row for a request **177**. The one or more computers **200** may assemble request **177** to include a header **173** to be displayed initially (FIG. **1**D), followed by content in the form of one or more groups **174** of line items **174**A-**174**N (FIG. **1**E). An approver **176** (FIG. **1**C) may select request **177** for display on mobile device **170** in a normal manner, e.g. by selecting it in a list (see FIGS. **8**B, **8**E and **8**H) of multiple requests requiring approval. Mobile device **170** may be implemented to include specialized circuitry such as GPS circuitry, cellular phone circuitry and sensors, as well as computer **1000** in turn including one or more hardware components as illustrated in FIG. **7**A and/or software components illustrated in FIG. **7**B and discussed below.

When selected, header **173** of request **177** may initially be displayed on mobile device **170** (as shown in FIG. **1**D). Header **173** includes one or more attributes in the form of name value pairs. In the example illustrated in FIG. **1**D, header **173** includes attributes specific to a module that created the request **177**, such as attribute **173**A with the name "Expense Report for" and value Horton, Conor, attribute **173**B with the name "Individual's Cost Center" and value **740**, attribute **173**C with the name "Expense Report Total" and value 295.00 USD, attribute **173**D with the name "Purpose" and value "Expense Report Testing **15**". In addition, header **173** includes attributes that are generic to requests (e.g. independent of which module created the request **177**), such as attribute **173**K with the name "From" and the value "Horton, Connor", attribute **173**L with the name "To" and the value "Brown, Casey", attribute **173**M

with the name "Sent" and the value "May 21, 2014", attribute **173**N with the name "Due" and the value "May 26, 2014", attribute **173**O with the name "ID" and the value "3076482".

Header **173** shown in FIG. **1**D includes an attribute **173**F with the name "Expense Report Details" and the value is a link that is operable by user input to display a screen displaying a group **174** of line items (also referred to as a region), with each line item being indicative of a specific expense as illustrated in FIG. **1**E. Header **173** shown in FIG. **1**D includes another attribute **173**G with the name "Action History" and the value is another link that is operable by user input to display another group of line items (also referred to as another region, not shown), which identify an action previously taken on the current request **177**, and may include a time stamp, showing a specific date and a specific time (on the specific date), when the action was taken. Similarly, an optional header attribute **173**H identifies yet another group of line items (also referred to as yet another region) also selectable by user input, to reveal one or more attachments e.g. a restaurant receipt which may be included in a request (e.g. work item) by a requester (e.g. employee). Each group of line items (or each region) may include just one line item, or multiple line items. In some embodiments, a group (or region) in which there are no line items is not transmitted by runtime operation **140** to mobile device **170** (i.e. effectively non-existent). Accordingly, the just-described last three header attributes **173**F, **173**G and **173**H identify three groups of line items (or three regions) of request **177**.

Individual line items **174**A . . . **174**I . . . **174**J . . . **174**N (FIG. **1**E) are transmitted by runtime operation **140** to mobile device **170**, e.g. as content of request **177**. Hence, when header attribute **173**F is selected by user input touching the panel thereof, a header displayed by mobile device **170** in FIG. **1**D (e.g. displayed based on receipt of XML to render a header screen as shown in FIG. **6**A) is replaced by a display of individual line items **174**A-**174**N identifying corresponding expenses, as shown in FIG. **1**E (e.g. displayed based on receipt of XML to render a details screen as shown in FIG. **6**B). For illustrative purposes, only four line items are shown in FIG. **1**E, although there may be any number of such line items. As illustrated in FIG. **1**E, each of line items **174**A-**174**N includes several name value pairs. For example, line item **174**I has four name value pairs, as follows: a first name "Expense Type" and a first value "Car Rental", a second name "Justification" and a second value "Car rental expenses", a third name "Reimbursable Amount" and a third value "34.00 USD", a fourth name "Date" and a fourth value "Jun. 11, 2014." Values in each of the just-described four name value pairs are received by reimbursement module **151** (FIG. **1**C), as user input in a request **183** from employee **181**, and stored in database **1120** as attributes.

Thus, numerous such line items are present in database **1120**, and the specific line items **174**A-**174**N which are selected by runtime operation **140** (FIG. **1**C) for inclusion in content **174** of a request **177** is configurable in accordance with the invention, by a rule **165**A (FIG. **1**C), as noted above. Rule **165**A is configurable by user input from a client computer **160** of a human (e.g. developer **166**) and is associated with an identifier **165**B (FIG. **1**C) of a software code to be executed to render a group of one or more line items (also called "regions") when rule **165**A is satisfied. Rule **165**A and software code identifier **165**B together form a rule action pair **165** (FIG. **1**C), which corresponds to a line item group (e.g. group **173**F in FIG. **1**D) that is includable in a request **177**. Specifically, in a setup operation **130**, a framework **100** (FIG. **1**C) receives from developer **166** via his/her client computer **160**, user input identifying configuration information for each request **177** that may be displayed on mobile device **170**. The configuration information identifies one or more line item groups **173**F that is/are includable in a request **177** and one or more corresponding rule action pairs **165** to be used in conditionally rendering the includable line item groups **173**F. Client computer **160** may also be implemented as computer **1000** including one or more hardware components as illustrated in FIG. **7**A and/or software components illustrated in FIG. **7**B and discussed below.

Thereafter, in a runtime operation **140**, on receipt of a request identifier **172** (FIG. **1**C) identifying a specific request **177** (e.g. selected by user input from among a list of requests), framework **100** evaluates the rules corresponding to each line item group that is includable in the identified request **177**, to identify one or more line item groups **174** which are to be rendered (when their corresponding rule is found to be satisfied). Then, for each to-be-rendered line item group **174**, framework **100** executes (or initiates execution of) a software code identified in the rule action pair **165**, to obtain from a database **1120** one or more line items **174**A-**174**N in group **174**, each retrieved line item including one or more name value pairs. The name value pairs in each retrieved line item **174**I are transmitted as content of request **177**, in addition to a header **173**, to obtain user input indicative of approval or disapproval of request **177**.

Examples of tables in relational database **1120** are of two types, namely (a) pre-existing tables namely Work Item Templates, Workflow Attributes, and Work Items, and (b) configuration tables namely Configured Work Items, Header Attributes, Result Attributes, Line Items, Rules & software codes, Line Item attributes, and programmatic method parameters mapping. For example, attributes (such as Workflow Attributes, Header Attributes, Result Attributes) may be stored as name value pairs, wherein the names in name value pairs are implemented as columns in a relational database table, and the values in the name value pairs may be stored in the rows ("database rows") of the relational database table, in database **1120**.

A work item is just one illustrative example of a request **183** (FIG. **1**C) used in a software application **150** (FIG. **1**C) which happens to be implemented as enterprise resource planning (ERP) software illustrated in FIG. **1**F. As another example, software application **150** (FIG. **1**C) may be implemented in some embodiments as gaming software (not shown), wherein a request **183** may contain a token (not shown) submitted by a team member (who is a requester) to a captain (who is an approver), and the token may identify a specific weapon in an armory (not shown) when the specific weapon is needed by the team member for use in the game only. Thus, FIG. **1**C generically illustrates several embodiments in accordance with the invention, while FIG. **1**F more specifically illustrates in greater detail certain specific exemplary embodiments.

Although desktop computer clients **181** and **186** are shown for illustrative purposes in FIG. **1**C as being used by employees **181** and **185** to interface with modules **151** and **152** to generate data for work items (based on requests **183**, **187**), such an employee **185** may instead use a mobile device **189** to perform the same acts, as illustrated in FIG. **1**F. Similarly, desktop computer **160** in FIG. **1**C is used by developer **166** to interface with framework **100** to provide configuration information for conditional execution of a specific software code (when an associated rule is met) to process a work item based on line items includable therein.

Such a developer **166** may instead use a mobile device **167** to perform the same acts, as illustrated in FIG. **1**F.

Moreover, although request **177** transmitted by framework **100** to mobile device **170** includes two portions **173** and **174** thereof in a single message as illustrated in FIG. **1**C, such portions may be transmitted individually as illustrated in FIG. **1**F. Specifically, a request's line item group **174** may be transmitted by framework **100** to mobile device **170** in response to receipt of a region identifier **178** that identifies the line item group **174**. Region identifier **178** (FIG. **1**F) may be received by mobile device **170** as one value in the name value pairs received in header **173**, and this one value identifies line item group **174** in a link operable by user input (as described above in reference to FIG. **1**D). Also, header **173** is optional and may or may not be transmitted by framework **100** to mobile device **170** prior to transmission of a work item's line item group **174** as content therein. Accordingly, numerous such embodiments in accordance with the invention will be readily apparent in view of this detailed description.

Some embodiments of computer(s) **200** perform setup operation **140** after performance of one or more legacy operation(s), such as operation **210** (FIG. **2**) to install one or more applications, each of which may include one or more software code(s), such as reimbursement module **151** and requisition module **153** (FIG. **1**C). Operation **210** creates (and/or receives) templates **211** (FIG. **2**) to be used in instantiating work items, during execution of module(s) **151**, **152**. Templates **211** are identified by unique names (also called work item template names), and in several embodiments it is one of these names that is received from developer's computer **160** (FIG. **1**C) in an act **231** (FIG. **2**) by setup operation **130**. In such embodiments, prior to act **231**, setup operation **130** transmits to developer's computer **160** (FIG. **1**C), a list **302** (FIG. **3**A) of names of work item templates e.g. as illustrated by screen **301** (FIG. **3**A). Templates **211** may be partially identified by workflow names corresponding to respective modules, e.g. workflow name **351** of value "Requisition" (FIG. **3**A) identifies one or more templates that are used by requisition module **153** in ERP software **150** (to obtain and store in a database, data related to work items). Developer **166** operates a mouse **201** (FIG. **3**A) to place cursor **303** on a button **304**A to identify the work item template to be configured and on clicking the mouse **201**, developer's computer **160** transmits work item template name **302**A to setup operation **130**, which is received in act **231** as noted above.

List **302** (FIG. **3**A) may be generated by setup operation **130** (FIG. **2**) in response to a search, e.g. on a workflow name "Requisition" as illustrated in FIG. **3**A. A workflow name identifies a process (also called "business process") that is followed by an instantiation of a work item template (also called work item) during its lifecycle, from creation to completion, including interactions with one or more humans (e.g. employees **181**, **185**) and/or other processes (e.g. of modules **151**, **153**). A work item's interactions with business processes and/or humans may create and/or complete other work items. A search to generate list **302** may identify other criteria, e.g. work item template's name, also illustrated in FIG. **3**A. Thus list **302** may be generated in different ways in different embodiments, and developer **166** selects a work item name **302**A identified in the search results list, and thus template name **302**A is received in act **231** (FIG. **2**). Note that in alternative embodiments, screen **301** may provide an input box for developer **166** to provide user input (by typing on a keyboard) in the form of a string of characters which define a new template name for a work item.

In an act **232** of operation **130**, identifiers (also called "attribute identifiers") of one or more attributes ("header attributes") **306**A . . . **306**I . . . **306**N in the template named in act **231** are received for use in rendering the header of the work item, on being selected by developer **166** as renderable, e.g. by selection (in check boxes) from among a group of attributes **306** in screen **305** as illustrated in FIG. **3**B. The group of attributes **306** may include one or more attributes (such as the attribute with name "#FROM_ROLE") that are not selectable for inclusion, which are included in the work item's header **173** by default. Each of the just-described attributes in group **306** includes both an internal name (e.g. "#FROM_ROLE") and a display name (e.g. "From Role"). It is the just-described display name which is included as the name in a name value pair, when request **177** is processed to generate header **173** (FIG. **1**C) which is returned by runtime operation **140**.

Also, act **232** may receive identifiers (also called "attribute identifiers") of additional attribute(s) ("result attributes") **307**A and **307**B, on being identified by developer **166** as being associated with corresponding labels, by selection in drop-down list boxes of screen **305** (FIG. **3**B). It is the just-described result attributes **307**A and **307**B which contain an approver's response **175** (FIG. **1**C) to approve or reject the work item, e.g. by touching button **1731** or button **173**J displayed on mobile device **170** (FIG. **1**D). Note that act **232** is optional because in some embodiments the information described above as being received in act **232** is not accessible to developer **166**, e.g. hard coded or preconfigured ahead of time.

After receipt of a work item template's name in act **231** (FIG. **2**) and optional receipt of header and result attributes in act **232**, another act **233** is performed in setup operation **130** to receive a set of identifiers (also called "region identifiers") of one or more groups **310**A, **310**B (FIG. **3**C) of line items that are includable in the work item template identified in act **231**. Groups (also called 'regions') **310**A, **310**B may be identified by corresponding names **311**A, **311**B, e.g. "Requisition_Lines_Yes" may be received by user input (e.g. via a keyboard) as name **311**A in a field of a line in screen **308** (FIG. **3**C). Screen **308** is supplied to client computer **160** by setup operation **130**, and each of the lines for corresponding groups **310**A, **310**B (FIG. **3**C) may be generated by developer **166** clicking on a new button **309** in screen **308**. Each of the lines for groups **310**A, **310**B in screen **308** identifies, in addition to the just-described name, a sequence number **312**A, **312**B according to which the groups are to be processed, relative to one another.

For each of groups **310**A and **310**B that are identified in act **233**, setup operation **130** receives at least one rule action pair in an act **234**. Certain embodiments enable a single line item group to be associated with multiple rule action pairs, so that the same line item group may be rendered differently in a request (e.g. work item) **177** by performance of different actions when different rules are satisfied. In such embodiments, the names in column **311**C need not be unique, i.e. the same name of a specific line item group may occur multiple times when multiple rule action pairs are associated therewith. However, some embodiments limit each line item group to being associated with only one rule action pair, so that each name in column **311**C is required to be unique.

Moreover, a rule action pair received in act **234** may be received from client computer **160** either in a common message in which the set of region identifiers of one or more groups **310**A, **310**B are also received in act **233** or in separate messages depending on the embodiment. In some embodiments, developer **166** may click on a button **313**A

shown in screen **308** in the line for group **310**A (FIG. **3**C) to define a rule by identifying an operator, an operand and a constant as illustrated in FIG. **3**D and described below. The developer **166** may further click on another button **314**A in the same line for group **310**A (FIG. **3**C) to define an action to perform by identifying a specific software code, as described below in reference to FIGS. **3**E-**3**H.

In some embodiments, developer **166** clicks on button **313**A (FIG. **3**C) in a rule column of screen **308** to obtain a screen **315** (FIG. **3**D). Screen **315** is displayed in an illustrative embodiment as a portion of screen **308** at the bottom thereof, and includes an first field **315**A to receive user input identifying an operand, a second field **315**B to receive user input identifying an operator, and a third field **315**C to receive user input identifying a constant. The constant is received in field **315**C as a string of characters (e.g. via a keyboard). The operator is received in field **315**B as a selection from among a set of predefined operators that are displayed in a drop-down list box (not shown) which is displayed by clicking an arrow icon on the right side of field **315**B. The operand is received in field **315**A also as a selection from among a set of operands that are displayed in another drop-down list box (not shown) which is displayed by clicking the arrow icon on the right side of field **315**A.

The set of operands which are displayed in field **315**A (FIG. **3**D) for selection by developer **166** depend on a type of operand identified in another field **315**D. The type of operand is received in field **315**D also as another selection from among a set of operand types that are displayed in yet another drop-down list box which is displayed by clicking the arrow icon on the right side of field **315**D. As shown in FIG. **3**D, the set of operand types includes "attribute" as one operand type and "software" as another operand type. Selection of the "attribute" operand type in field **315**D (FIG. **3**D) results in the set of attributes being made available for selection in field **315**A to include, in some embodiments: attributes related to the work item, attributes related to a work flow of the work item, and optionally attributes related to a module that created the work item.

Selection of the "software" operand type in field **315**D results in field **315**A being available for user input identifying the operand to be output of a software code ("rule-operand software code"), such as (1) output of a method ("rule-operand programmatic method") in an application (not shown) which may be expressed in any programming language such as Java, C++, and/or (2) output of PL/SQL code containing a query to a relational database which may be expressed in the structured query language SQL. Subscreen **315** (FIG. **3**D) includes a field **315**E to receive user input as a string of characters (e.g. via a keyboard) identifying a name of rule **316**, such as the name "Is Contractor Requisition." Although only one rule **316** is shown in table **315** in FIG. **3**D for the line item group "Requisition_Lines_Yes", multiple such rules may be configured in table **315** for the same line item group, and during runtime operation **140** whichever rule is satisfied that rule's action is performed.

In some embodiments, developer **166** clicks on button **314**A (FIG. **3**C) in software code column **314** of screen **308** to obtain a screen to identify an action to be performed, e.g. by execution of a specific software code identified by button **314**A which may be implemented as a database query expressed in a structured query language (SQL) and/or any other programming language, such as Java, PL/SQL or C++ identified in a screen **317** as described below. Note that the specific software code ("action software code") identified by button **314**A (FIG. **3**C) which is to be executed in an action (selected as shown in FIG. **3**E) of a rule action pair is different from another software code ("rule-operand software code") to be executed to obtain an output thereof which forms an operand **315**A of operand type **315**Z labeled "Software" within a rule **315** (FIG. **3**D) in the rule action pair. Thus, two software codes may be specified, one in the rule ("rule-operand software code") and another in the action ("action software code") of a rule action pair of some embodiments.

A specific software code ("action software code") to be executed by computer(s) **200**, to perform the action of a rule action pair, may be selected by a developer to be a programmatic method ("action programmatic method") in an object of an application module, the application module being selected from among a set of application modules deployed in computer(s) **200**, as follows. Screen **317** (FIG. **3**E) includes a field **318** to receive user input identifying an application module by name. For example, developer **166** may search (by clicking on a search icon located to the right of field **318**), to obtain a popup window (not shown) which allows a search for application modules that have been deployed in computer(s) **200**. When a specific application module is identified by a developer **166** making a selection in field **318** e.g. by selecting the name of an application module, screen **317** (FIG. **3**E) is updated in a column **319**A, to show all data access objects that are included in the specific application module identified in field **318**. Developer **166** may select one or more objects in column **319**A, followed by clicking on button **319**M to move the selected objects to another column **319**S. For example, in screen **317** of FIG. **3**E, an object named "ReqLinesNotificationsVO" is received via column **319**S (by setup operation **130**) as a selection from among a set of objects in column **319**A.

Thereafter, developer **166** clicks on button **319**L (FIG. **3**E) to load the object(s) identified in column **319**S into a subscreen **320** shown at the bottom of screen **317**, for use in identifying a specific method therein ("action programmatic method") to be used to access data of a request (e.g. work item). For this reason, the object(s) identified in column **319**S are also referred to herein as data access objects. Subscreen **320** (FIG. **3**E) shows a software program's identifier which is received via field **320**A (by setup operation **130**) as a selection from among a set of software programs (e.g. Java classes) in selected object(s) **320**D. Thereafter, developer **166** may select a method ("action programmatic method") in field **320**B, and the selected method's name forms an identifier of a specific software code to be executed as the action in a rule action pair. In screen **317** of FIG. **3**E, an action programmatic method named "initQuery(**2**)" is received via field **320**B (by setup operation **130**) as a selection from among a set of action programmatic methods available in the specific software program (e.g. Java class) selected in field **320**A.

When selection of a method ("action programmatic method") is received via field **320**B, screen **317** of some embodiments is updated to display a table **323** (FIG. **3**F) in which are displayed all the outputs of the selected method, e.g. one line per output. Specifically, table **323** includes a first column **323**A which displays an internal name of an output attribute of an action programmatic method **320**B selected in subscreen **320** (FIG. **3**E) and available for inclusion in a region to be displayed to an approver (e.g. which can be rendered on mobile device **170**), a second column **323**B which identifies for the just-described attribute, a name to be rendered by mobile device **170** in a region to be displayed to the approver (e.g. manager **176**), a third column **323**C which identifies a sequence number that is

used (by runtime operation **140** of framework **100**) to output the attributes in a sequence relative to one another, and a fourth column **323**D identifying the attribute as being rendered (or not) in the work item **177**.

Column **323**B is used (by setup operation **130**) to receive user input in each line within table **323**, in the form of a string of characters typed by developer **166** on a keyboard, the character string identifying the attribute's name to be rendered in the work item. Similarly, column **323**D is used (by setup operation **130**) to receive user input (e.g. by developer **166** clicking on a mouse) in each line identifying whether or not the attribute is to be rendered (or otherwise used) in the work item. For example, as illustrated in column **323**D (FIG. **3**F), in a third line of table **323** an attribute with internal name "FundSourceNotKnown" is identified (to setup operation **130**) as not to be rendered by the absence of a check mark, while other attributes in table **323** are identified as renderable by the presence of check marks in the respective lines.

At this stage, screen **317** includes a reorder sequence button **319** to be used by developer **166** to change the sequence numbers shown in column **323**C. Specifically, in response to button **319** being clicked, a pop-up screen **319**S is displayed, listing the output attributes which are to be rendered, and user input is received e.g. from developer **166** selecting an attribute in the listing and moving it from its current position in the sequence, e.g. move attribute named SuggSupplier upwards by clicking on button **319**B.

Developer **166** may click on button **320**C (FIG. **3**G) to obtain a subscreen **321** (shown in FIG. **3**H) for use in mapping input parameters of the method ("action programmatic method") selected in field **320**B to one or more attributes of the work item **177**. Subscreen **321** includes a first column **321**A that identifies each input parameter of the method in field **320**B, a second column **321**B identifies a type of each input parameter, and a third column **321**C to receive user input in field **322** selecting an attribute of the work item **177**, via a drop down list box that identifies all attributes of the work item. In screen **317** of FIG. **3**H, an attribute named "Document Id" is received via field **322** (by setup operation **130**) as a selection from among the set of attributes in the drop down list box. The developer's selection is stored in a configuration table in the database, for use in runtime operation. Specifically, the mapping of each attribute in column **321**C to a corresponding input parameter in column **321**A (FIG. **3**H) is used in runtime operation to pass a value of the attribute as the input parameter to the method ("action programmatic method") selected in field **320**B (FIG. **3**E).

Referring back to FIG. **2**, during act **234** (as described above), configuration information is received identifying each line item group (e.g. region identifier) that is includable in work item **177** and a corresponding rule action pair associated therewith (e.g. rule action pair identifier), and this configuration information is stored in tables **236** (FIG. **2**) of a relational database (also called "configuration tables"). After act **234** is completed, an act **237** is performed in operation **130**, to check whether receipt of rules for each group of line items includable in work item **177** has been completed, and if not return to act **234** (described above). When the answer in act **237** is yes, operation **130** performs an act **238** to check if configuration information is to be received for any more work items, and if so returns to act **231**. When no more configuration information is to be received, setup operation terminates.

Runtime operation **140** (FIG. **2**) may start at any time after configuration information is received for at least one work item **177** by setup operation **130**. Specifically, in an act **241**, runtime operation **140** receives a request identifying work item **177** and uses a name of the work item to identify all line item groups that are identified in configuration tables **236** as being includable in the work item **177**. Thereafter, runtime operation **140** checks in an act **242** whether any rule, in a rule action pair associated with an includable line item group identified in act **241**, is satisfied. If not, runtime operation **140** goes to act **243** to check if all rules (and correspondingly all line item groups includable in the work item **177**) have been processed, and if not returns to act **242**. When all rules are found to have been processed in act **243**, runtime operation **140** returns to act **241** (described above).

In act **242** if the answer is yes, then runtime operation **140** goes to act **244**. In act **244**, runtime operation **140** executes the specific software code which is identified as an action in the rule action pair wherein the rule is found to be satisfied (in act **242**). On execution of the specific software code in act **244**, runtime operation **140** obtains one or more name value pairs from pre-existing tables of a relational database **1120**. Thereafter, runtime operation **140** performs an act **245** to transmit, as content of the work item **177**, the name value pairs which were retrieved in act **244**.

In some embodiments, after an app for requests is started, mobile device **170** receives a list of requests (e.g. work items) from one or more computer(s) **200**. Mobile device **170** of these embodiments displays the list in act **251** and receives user input on a selected request (e.g. work item), and this user input is transmitted to the one or more computer(s) **200**. Thereafter, in act **252**, mobile device **170** of such embodiments receives and displays a header of a selected request (e.g. selected work item), followed by act **253** in which mobile device **170** displays a selected line item group within the selected request (e.g. selected work item). After act **253**, the mobile device **170** obtains a response (or decision) on the request (e.g. work item), and in an act **254** the response is transmitted as manager **176**'s user input to the one or more computer(s) **200**. Thus, in act **245**, runtime operation **140** in the one or more computer(s) **200** receives the user input (e.g. from manager **176** in FIG. **1**B) indicative of the response (e.g. approval, disapproval) on the request (e.g. work item) **177**. Also in act **245**, runtime operation **140** then stores the decision in the relational database **1120** and then returns to act **241** (described above).

FIG. **4**A-**4**C illustrate, in flow charts, acts performed by one or more computers **200** by use of one or more processors programmed with a sequence of instructions of software stored in one or more memories, to implement setup operation **130** of framework **100**, as follows. Specifically, in an act **411** (FIG. **4**A), setup operation **130** transmits a screen of the type illustrated in FIG. **3**A to client computer **160** to enable developer **166** to search for work item templates that have been previously defined. Subsequently, in act **412**, setup operation **130** receives user input and builds search criteria to query a table "Work Item Templates" preexisting in the relational database **1120**. Note that certain tables which are described herein as preexisting in relational database **1120** are normally used by one or more business applications installed in operation **210** that implement business logic thereon, to create work items in the normal manner.

Thereafter, in act **413** (FIG. **4**A), setup operation **130** transmits to client computer **160** a list of names of query-matching Work Item Templates (as shown in FIG. **3**A). Then, in act **414**, setup operation **130** receives user input as the developer's selection of a Work Item Template to set up (see FIG. **3**A). This is followed by an act **415** wherein setup operation **130** stores the name of the developer-selected

work item template in a configuration table named "Configured Work Items" in the relational database **1120**. The just-described acts **411**-**415** are included in a procedure **410** performed by setup operation **130** to identify configured work items.

Subsequently, for the selected work item template subjected to procedure **410**, setup operation **130** performs a procedure **420** (FIG. **4**B) to configure a header to be rendered in a work item as follows. In act **421**, setup operation **130** retrieves attributes from a table named "Workflow Attributes" that is pre-existing in the relational database **1120**. Thereafter, in an act **422**, setup operation **130** transmits to client computer **160** a screen (see FIG. **3**B) with a list of attributes specific to the work item and a field to select each attribute as being renderable. Then, in an act **423**, setup operation **130** transmits to client computer **160** another list of attributes for use in configuring how runtime operation **140** captures decisions by users, such as "approval" or "disapproval". Next, in act **424**, setup operation **130** receives user input from developer's client computer **160** on the just-described two lists and persist them to the respective configuration tables "Header Attributes" and "Result Attributes".

In some embodiments, setup operation **130** performs a procedure **430** (FIG. **4**C) as follows. In act **431**, setup operation **130** transmits a screen to create line item groups includable in Work Item (FIG. **3**C). In act **432**, setup operation **130** receives user input identifying name(s) of line item group(s). In act **433**, setup operation **130** transmits a screen to receive a rule for each identified line item group. In act **434**, setup operation **130** receives user input on the rule identifying operator, operand type, operand and constant (FIG. **3**D). In act **435**, setup operation **130** persists to configuration table "Rules and Software Codes", line item's name and rule. In act **436**, setup operation **130** transmits an option to select a type of a specific software code to be executed, to obtain multiple name value pairs for rendering in line item, e.g. type may be: a database query in SQL or a method in a data access object ("action programmatic method").

In act **437**, setup operation **130** transmits a screen to identify a specific software code based on identifiers (also called "software code identifiers") of data access objects in the Rules & software codes table, which are executed to retrieve multiple name value pairs, e.g. implemented as views on preexisting tables "Details Data Source". In act **438**, setup operation **130** receives via user input, Identifiers of data access objects or SQL Text. In act **439**, setup operation **130** parses definitions of data access objects or SQL Text. In act **440**, setup operation **130** transmits a screen to select for rendering, and reordering: attributes of data access objects or SQL. In act **441**, setup operation **130** transmits a choice to select a software program from among a set of software programs in the application module or in a data access object, and to select a method in the selected software program ("action programmatic method"). In act **442**, setup operation **130** receives & parses a selected method ("action programmatic method") and identifies input parameters. In act **443**, setup operation **130** transmits a screen to map the input parameters to attributes of work item (FIG. **3**H). In act **444**, setup operation **130** receives user input identifying a correspondence between each input parameter and a work item attribute, and stores this information to configuration table "Method Parameters Mapping".

FIG. **5**A-**5**D illustrate, in flow charts, acts performed by one or more computers **200** by use of one or more processors programmed with a sequence of instructions of software stored in one or more memories, to implement runtime operation **140** of framework **100** in exemplary embodiments as follows. In act **511**, runtime operation **140** receives from mobile device **170** of manager **176** a "Get Summary" message. In act **512**, runtime operation **140** retrieves from the table "Configured Work Items" (see FIG. **4**A, act **415**) the names of work item templates. In act **513**, runtime operation **140** fetches from preexisting table "Work Items", a Summary (or list) of Work Items which were instantiated by use of the template named in act **512** (above). In act **514**, runtime operation **140** prepares an XML response of Summary. In act **515**, runtime operation **140** returns a response to mobile device **170**. Acts **511**-**515** are performed in a procedure **510** (FIG. **5**A).

In act **521** (FIG. **5**B), runtime operation **140** receives from manager **176**, a "Get Details" message. In act **522**, runtime operation **140** gets from the message, an Identifier of Work Item. In act **523**, runtime operation **140** retrieves from table "Configured Work Items", the following: Workflow Name (or request type) and Work Item Template Name for the work item ID (or request ID). In act **524** (FIG. **5**B), runtime operation **140** uses the Workflow Name and Work Item Template Name to retrieve metadata from the following configuration tables: (a) Header Attributes, (b) Result Attributes, (c) Line Items (d) Rules & software codes (e) Line item attributes and (f) Method Parameters Mapping. In act **525**, runtime operation **140** evaluates the rules & executes the specific software codes to obtain line items, with each line item including one or more name value pairs (also called "details"). Specifically, in act **525**, multiple name value pairs are retrieved by executing data access objects, e.g. implemented as views on preexisting tables named "Details Data Source". In act **526**, runtime operation **140** uses metadata to transform the multiple name value pairs into content of the work item (e.g. by arranging them in a specific sequence of multiple lines relative to one another, as specified in column **323**C of FIG. **3**F). In act **527**, runtime operation **140** prepares XML with header attributes, result attributes, and details.

Note that act **524** of some embodiments may be implemented as illustrated in FIG. **5**C by performance of acts **524**A-**524**C as follows. In act **524**A, runtime operation **140** retrieves attributes of the Work Item which are renderable in the header from a configuration table "Header Attributes". Thereafter, in act **524**B, runtime operation **140** retrieves the Result Attributes for Actions in Work Item from configuration table "Result Attributes". Subsequently, in act **524**C, runtime operation **140** maps the work item's line items, e.g. by performing the acts **524**C**1**-**524**C**3** illustrated in FIG. **5**D as follows. In act **524**C**1**, runtime operation **140** retrieves from configuration table "Rules & software codes" one or more Rules that apply to corresponding line item groups that are includable in the current work item. Then, in act **524**C**2**, runtime operation **140** identifies data access objects containing the specific software code to be executed, also from configuration table "Rules & software codes" corresponding to each applicable rule identified in act **524**C**1**. Finally, in act **524**C**3**, runtime operation **140** identifies from configuration table "Line Item Attributes", the attributes in data access object to be returned in response.

FIGS. **6**A and **6**B illustrate a work item's header **173** (see FIG. **1**D) and a corresponding group **174** (see FIG. **1**E) of line items generated by runtime operation **140** of framework **100** by performance of act **527** in FIG. **5**B, when a rule is satisfied, for the first line item group **310**A named "Requisition_Lines_Yes" in FIG. **3**C. FIGS. **6**C and **6**D illustrate a

work item's header **173** (see FIG. **1**D) and a corresponding group **174** (see FIG. **1**E) of line items generated by runtime operation **140** of framework **100** by performance of act **527** in FIG. **5**B, when a different rule is satisfied, for the second line item group **310**B named "Requisition_Lines_No" in FIG. **3**C. Comparison of FIGS. **6**B and **6**D shows that the name value pairs that are displayed are different, based on corresponding different rules being satisfied, which result in different regions being rendered (e.g. region id=1022 as identified in the "body" portion of FIG. **6**A is rendered in FIG. **6**B, whereas region id=1023 as identified in the "body" portion of FIG. **6**C is rendered in FIG. **6**D).

The above-described associations between rules and corresponding identifiers (also called "software code identifiers") of specific software codes (which form rule action pairs as noted above), as well as all the rules themselves are stored in one or more configuration tables **236** (FIG. **2**) by one or more processors **1105** that are included in certain embodiments of the one or more computers **200** of the type described above. In several such embodiments, configuration tables **236** and/or preexisting tables **249** (which hold information related to work items) are stored in relational database **1120** (FIG. **1**C) that is accessed via commands in a Structured Query Language (SQL) to a relational database management system (RDBMS) **1130**. A specific RDBMS **1130** which is executed by one or more processors **1105** depends on the embodiment, although some embodiments use RDBMS software called "ORACLE Database **12***c*" available from Oracle Corporation of Redwood Shores, Calif., USA. Such database(s) **1120** may additionally be used to store work items, and/or multiple name value pairs included as content of line items, depending on the embodiment.

Computer(s) **1000** illustrated in FIGS. **7**A and **7**B may be used to implement server computer(s) **200** described above, and/or client computers **182**, **186**, **160** and/or mobile devices **170**, **167** and **189**. Specifically, computer(s) **1000** of some embodiments include a bus **1102** (FIG. **7**A) or other communication mechanism for communicating information, and one or more processor(s) **1105** coupled with bus **1102** for processing information. Computer(s) **1000** use (as the above-described memory) a main memory **1106**, such as a random access memory (RAM) or other dynamic storage device, coupled to bus **1102** for storing information and instructions (e.g. to perform act(s) of FIGS. **1**A-**1**B, FIG. **2**, FIGS. **4**A-**4**C and **5**A-**5**D) to be executed by processor(s) **1105** (FIG. **1**C). Main memory **1106** (FIG. **7**A) also may be used for storing temporary variables or other intermediate information during execution of instructions (e.g. in modules **461**-**466**) by processor **1105**. Computer(s) **1000** further include a read only memory (ROM) **1104** or other static storage device coupled to bus **1102** for storing static information and instructions for processor **1105**, such as software in the form of a browser. A storage device **1110**, such as a magnetic disk or optical disk, is provided and coupled to bus **1102** for storing information and instructions.

Computer(s) **1000** (FIG. **7**A) may be coupled via bus **1102** to a display device or video monitor **1112** such as a cathode ray tube (CRT) or a liquid crystal display (LCD), for displaying information (e.g. via a browser) to a computer user (e.g. user **411**, **441** or **451**) on the display **1112**. An input device **1114**, including alphanumeric and other keys (e.g. of a keyboard), is coupled to bus **1102** for communicating information (such as user input, e.g. from any user **181**, **185**, **166**, or **170**) to processor **1105**. Another type of user input device is cursor control **1116**, such as a mouse **201** (FIG. **3**A), a trackball, or cursor direction keys for communicating information and command selections to processor **1105** and for controlling cursor movement on display **1112**. This input device typically has two degrees of freedom in two axes, a first axis (e.g., x) and a second axis (e.g., y), that allows the device to specify positions in a plane. In addition to display device **1112**, computer(s) **1000** may include a speaker (not shown) as another output device for use by processor **1105** in interacting with any of user(s) **181**, **185**, **166**, or **176**.

As described elsewhere herein, execution of ERP software **150** (FIG. **1**C) in computer(s) **1000** (FIG. **7**A) may be implemented by one or more processor(s) **1105** executing one or more sequences of one or more instructions that are contained in main memory **1106**. Such instructions may be read into main memory **1106** from another non-transitory computer-readable storage medium, such as storage device **1110**. Execution of the sequences of instructions contained in main memory **1106** causes processor **1105** to perform setup operation **130** as illustrated in FIG. **1**C and/or to perform runtime operation **140** also illustrated in FIG. **1**C. In alternative embodiments, hard-wired circuitry may be used in place of or in combination with software instructions in modules **110** and **120** located in memory **1000** as illustrated in FIG. **7**B, to perform the corresponding operations **130** and **140** of FIG. **1**C. Also, although framework **100** is included in ERP software **150** as illustrated in FIG. **1**C in some embodiments, framework **100** may be implemented outside ERP software **150** as illustrated in FIG. **7**B.

The term "non-transitory computer-readable storage medium" as used herein refers to any non-transitory storage medium that participates in providing instructions to processor **1105** (FIG. **7**A) for execution. Such a non-transitory storage medium may take many forms, including but not limited to (1) non-volatile storage media, and (2) volatile storage media. Common forms of non-volatile storage media include, for example, a floppy disk, a flexible disk, hard disk, optical disk, magnetic disk, magnetic tape, or any other magnetic medium, a CD-ROM, any other optical medium, punch cards, paper tape, any other physical medium with patterns of holes, a PROM, and EPROM, a FLASH-EPROM, any other memory chip or cartridge that can be used as storage device **1110**, to store program code in the form of instructions and/or data structures and that can be accessed by computer(s) **1000**. Volatile storage media includes dynamic memory, such as main memory **1106** which may be implemented in the form of a random access memory or RAM.

Instructions to processor **1105** (FIG. **7**A) can be provided by a transmission link or by a non-transitory storage medium from which a computer can read information, such as data and/or code. Specifically, various forms of transmission link and/or non-transitory storage medium may be involved in providing one or more sequences of one or more instructions to processor **1105** for execution. For example, the instructions may initially be comprised in a non-transitory storage device, such as a magnetic disk, of a remote computer. The remote computer can load the instructions into its dynamic memory (RAM) and send the instructions over a telephone line using a modem.

A modem local to computer(s) **1000** (FIG. **7**A) can receive information about a change to a collaboration object on the telephone line and use an infra-red transmitter to transmit the information in an infra-red signal. An infra-red detector can receive the information carried in the infra-red signal and appropriate circuitry can place the information on bus **1102**. Bus **1102** carries the information to main memory **1106**, from which processor **1105** retrieves and executes the instructions. The instructions received by main memory

1106 may optionally be stored on storage device 1110 either before or after execution by processor 1105.

Computer(s) 1000 (FIG. 7A) also includes a communication interface 1115 coupled to bus 1102. Communication interface 1115 provides a two-way data communication coupling to a network link 1120 that is connected to a local network 1122. Local network 1122 may interconnect multiple computers (as described above). For example, communication interface 1115 may be an integrated services digital network (ISDN) card or a modem to provide a data communication connection to a corresponding type of telephone line. As another example, communication interface 1115 may be a local area network (LAN) card to provide a data communication connection to a compatible LAN. Wireless links may also be implemented. In any such implementation, communication interface 1115 sends and receives electrical, electromagnetic or optical signals that carry digital data streams representing various types of information.

Network link 1120 (FIG. 7A) typically provides data communication through one or more networks to other data devices. For example, network link 1120 may provide a connection through local network 1122 to a host computer 1125 or to data equipment operated by an Internet Service Provider (ISP) 1126. ISP 1126 in turn provides data communication services through the world wide packet data communication network 1124 now commonly referred to as the "Internet". Local network 1122 and network 1124 both use electrical, electromagnetic or optical signals that carry digital data streams. The signals through the various networks and the signals on network link 1120 and through communication interface 1115, which carry the digital data to and from computer(s) 1000, are exemplary forms of carrier waves transporting the information.

Computer(s) 1000 (FIG. 7A) can send messages and receive data, including program code, through the network(s), network link 1120 and communication interface 1115. In the Internet example, a server 1100 might transmit information retrieved from RDBMS database through Internet 1124, ISP 1126, local network 1122 and communication interface 1115. The sequences of instructions for performing the operations 130, 140 of FIG. 1C and/or one or more acts illustrated in FIGS. 1A-1B, 2, 4A-4C and 5A-5D may be executed by processor 1105 as these instructions are received, and/or stored in storage device 1110, or other non-volatile storage for later execution. In this manner, computer(s) 1000 may additionally or alternatively obtain instruction sequences and any related data in the form of a carrier wave.

FIG. 7A is a very low-level representation of many hardware components of one or more of computer(s) 1000, which may be used to implement computer(s) 200 to perform acts described above in reference to FIGS. 1A-1B, 2, 4A-4C and 5A-5D. Several embodiments have one or more additional software components in main memory 1106 as shown in FIG. 7B. In addition to main memory 1106, computer(s) 1000 may include one or more other types of memory such as flash memory (or SD card) and/or a hard disk and/or an optical disk (also called "secondary memory") to store data and/or software for loading into memory 1106 (also called "main memory") and/or for use by processor(s) 1105. In some embodiments, computer(s) 1000 of FIG. 7A implements a relational database management system 1130 to manage data in one or more tables 236, 249 of a relational database 1120 of the type illustrated in FIG. 7B. Such a relational database management system 1130 may manage a distributed database system that includes multiple databases, each table being stored on different storage mechanisms.

In some embodiments, the multiple databases are made to appear as a single database. In such embodiments, processor 1105 can access and modify the data in a relational database 1120 via RDBMS 1130 that accepts queries from various software codes e.g. action programmatic method 320B (FIG. 3E) in conformance with a relational database language, the most common of which is the Structured Query Language (SQL). The commands are used by processor 1105 of some embodiments to store, modify and retrieve configuration information and/or content of line items as rows of data ("database rows") from tables in relational database 1120.

Relational database management system 1130 further includes output logic that makes the data in a database table available to a user via a graphical user interface that generates a screen on a video monitor display 1112. In one example, the output logic of computer(s) 1000 provides results via a web-based user interface that depicts in a browser, information related to work items as illustrated in any one or more of FIGS. 3A-3G. Additionally and/or alternatively, screens responsive to a command in a command-line interface and display on a video monitor may be generated by computer(s) 1000.

In some embodiments of computer(s) 1000, functionality in the above-described operations or acts of FIGS. 1A-1B, 2, 4A-4C and 5A-5D is implemented by processor 1105 executing software in memory 1106 of computer(s) 1000, although in other embodiments such functionality is implemented in any combination of hardware circuitry and/or firmware and/or software in computer(s) 1000. Depending on the embodiment, various functions of the type described herein may be implemented in software (executed by one or more processors or processor cores) or in dedicated hardware circuitry or in firmware, or in any combination thereof. Accordingly, depending on the embodiment, any one or more of the means for performing operations or acts of FIGS. 1A-1B, 2, 4A-4C and 5A-5D can, but need not necessarily include, one or more microprocessors, embedded processors, controllers, application specific integrated circuits (ASICs), digital signal processors (DSPs), multi-core processors and the like.

Any non-transitory computer-readable medium tangibly embodying software (also called "computer instructions") may be used in implementing one or more acts or operations described herein and illustrated in FIGS. 1A-1B, 2, 4A-4C and 5A-5D. Such software may include program codes stored in memory 1106 and executed by processor 1105. Memory 1106 may be implemented within or external to processor 1105, depending on the embodiment. When implemented in firmware and/or software, logic to perform one or more acts or operations of FIGS. 1A-1B, 2, 4A-4C and 5A-5D may be stored as one or more computer instructions or code on a non-transitory computer-readable medium.

In some embodiments, one or more of computer(s) 1000 may include multiple processors, each of which is programmed with software in a memory 1106 shared with each other to perform operations 130, 140 of the type described above as illustrated in FIG. 1C. For example, a first processor 1105 in computer(s) 1000 may be programmed with software in memory 1106 to implement a setup module 110, to perform setup operation 130. A second processor 1105 in computer(s) 1000 may be programmed with software in memory 1106 to implement a runtime module 120, to perform runtime operation 140. Although two processors 1105 have been just described for some embodiments to

implement the respective means, in other embodiments a single processor **1105** may be used in a time shared manner to implement the just-described modules. Furthermore, in still other embodiments, one processor **1105** may be used in a time-shared manner to implement one or more parts of various modules. Furthermore, although processors **1105** have been described above for certain embodiments as being included in a single computer(s) **1000**, in other embodiments multiple such processors **1105** may be included in multiple computers **1000**, for example two computers **1000** may implement the two modules **110** and **120** to perform the two operations **130**, **140** described above. Additionally, in one or more such embodiments, one or more processor(s) **1105** with a bus **1103** execute ERP software **150** in computer(s) **1000**.

FIGS. **8**A-**8**J illustrate displays that are rendered by mobile device **170** of some embodiments, in response to performance by computer(s) **1000** of operations **130**, **140** of the type described above as illustrated in FIGS. **1**A-**1**C, **2**, **4**A-**4**C and **5**A-**5**D. Mobile device **170** includes a request application which is generic to multiple request types, and understands requests represented using a canonical XML structure, as illustrated by requests shown in FIGS. **6**A to **6**D. Some embodiments of request application in mobile device **170** does not contain any logic or data specific to a particular request type. In such embodiments, no changes are required to the request application in mobile device **170**, to display requests of any new type configured by setup operation **130**, followed by use thereof during execution of runtime operation **140** that produces the requests in the form of canonical XML documents in framework **100**. Illustrative examples of request types are Expense Reports, Purchase Requisitions, Purchase Orders, Invoices, and Timecards. Any new request type can be added to framework **100**, using setup operation **130** (e.g. as shown in FIGS. **3**A to **3**H), followed by generation of requests of the new request type by runtime operation **140**, followed by display of the new type of requests by the request app in mobile device **170**.

Specifically, FIG. **8**A illustrates an initial display of the request application ("app") **800** on execution thereof in mobile device **170**, including buttons that identify individual request types, e.g. an expenses button **179**B, a recruitment button **179**C, a requisitions button **179**D, a purchase orders button **179**E. The request app may include buttons unrelated to request types, such as a pending approvals button, a past approvals button, a settings button, an about button, and a signout button.

In response to a human (e.g. approver) touching expenses button **179**B, mobile device **170** transmits to server computer(s) **200** described above a message containing the request type of "expense." This message is used by server computer(s) **200** in performing act **143** to prepare and transmit to mobile device **170** for display therein a summary **805** (similar to list **171** shown in FIG. **1**C), identifying requests **805**A . . . **8051**, **805**J . . . **805**N (as shown in FIG. **8**B), as being available for display. In response to the human (e.g. approver) touching a specific request in summary **805**, mobile device **170** transmits to server computer(s) **200** a message that identifies the specific request **805**J (e.g. similar to request ID **172** shown in FIG. **1**C). In response, computer(s) **200** evaluate one or more rules to identify, one or more region(s) renderable in the specific request, followed by execution of specific software code(s) thereof, followed by preparation and transmission of one or more messages containing the specific request to mobile device **170** (e.g. similar to request **177** shown in FIG. **1**C).

The message(s) of a specific request may include one or more header(s) e.g. as regions **806** and **807** (FIG. **8**C) and one or more links to corresponding regions (or line item groups), such as a link **813** (FIG. **8**C) named "Expense Lines" and another link **814** (FIG. **8**C) named "Action History". Note that the name "Expense Lines" and the link **813** are an example of a name value pair in the header. Such message(s) may further include content to be displayed on operation of each link in the header, e.g. as a region **809** including display rows **810**-**812** (FIG. **8**D) which is displayed on operation of the link **813** (FIG. **8**C). As shown in FIG. **8**D, a single display row **810** includes four lines **810**A-**810**D, wherein each line includes a name and a value, e.g. line **810**C includes the name "Amount" and the value "123.00 USD". Similarly, display rows **811** and **812** shown in FIG. **8**D include lines **811**A-**811**D and lines **812**A-**812**D respectively. As will be readily apparent in view of this description, header and content of a request may be transmitted from the one or more computer(s) **200** to mobile device **170**, either together in a single message, or separately in two or more messages.

Similarly, in response to the human (e.g. approver) touching Requisitions button **179**C or Purchase Orders button **179**D mobile device **170** interacts with server computer(s) **200** to display summaries (or lists) of available requests, as shown in FIG. **8**E or **8**H respectively. Also similarly in response to the human touching a specific request in the available-request summaries shown in FIG. **8**E or **8**H, mobile device **170** interacts with server computer(s) **200** to display the header and content of the specific request identified in the respective available-request summary, e.g. as shown in FIGS. **8**F and **8**G, or as shown in FIGS. **81** and **8**J respectively. Accordingly, a request app of the type described above standardizes the user interface and document exchange between in mobile device **170** and server computer(s) **200**.

Various adaptations and modifications may be made without departing from the scope of the described embodiments. Numerous modifications and adaptations of the embodiments described herein are encompassed by the attached claims.

The invention claimed is:

1. A computer-implemented method of generating requests to be displayed, the computer-implemented method comprising:

in a setup operation, preparing and transmitting one or more first screens to receive, from one or more first computers, a set of identifiers of one or more regions that are includable in a request for user input indicative of at least one of approval or disapproval;

in the setup operation, for each includable region identified in the set, receiving, from the one or more first computers, a rule action pair corresponding to said each includable region, wherein the rule action pair comprises a rule and an identifier of a specific software code to be executed to render said each includable region when the rule is satisfied;

in a runtime operation, responding to receipt from a mobile device of a message that identifies the request, by evaluating in one or more second computers at least one rule in the rule action pair corresponding to at least one includable region identified in the set received for the request, to identify one or more regions to be rendered in displaying the request;

in the runtime operation, for at least one to-be-rendered region identified by the evaluating, executing in the one or more second computers, at least the specific software

code identified in the rule action pair corresponding to said at least one to-be-rendered region, to obtain from a relational database a plurality of first rows, each first row comprising a plurality of name value pairs; and

in the runtime operation, preparing one or more second screens comprising at least content of the request, said at least content of the request comprising the plurality of name value pairs in a plurality of second rows, each name value pair in the plurality of name value pairs being comprised in a single line of a second row in the plurality of second rows, each second row comprising a plurality of lines, the plurality of lines being sequenced relative to one another in a specific sequence received in the one or more first screens from the one or more first computers;

in the runtime operation, transmitting to the mobile device, said one or more second screens comprising at least content of the request; and

in the runtime operation, receiving and storing said user input in the relational database.

2. The computer-implemented method of claim **1** wherein said at least one rule comprises an operator, an operand and a constant, and the computer-implemented method comprises:

preparing and transmitting one or more third screens to: receive from the one or more first computers, a first selection identifying the operator in a set of operators;

receive from the one or more first computers, a second selection identifying the operand in a set of operands; and

receive from the one or more first computers, the constant;

wherein the operator, the operand and the constant are used in said evaluating.

3. The computer-implemented method of claim **2** wherein the specific software code identified in the rule action pair is a first software code, and the one or more third screens are configured to:

receive from the one or more first computers, a third selection identifying for the rule a type of the operand in a set of types;

wherein the set of types comprises:

a first type identifying the operand as an attribute of the request; and

a second type identifying the operand as a result of executing a second software code.

4. The computer-implemented method of claim **1** further comprising, prior to receiving the set of identifiers of one or more regions:

preparing and transmitting one or more third screens to receive, from the one or more first computers, search criteria to identify templates;

preparing and transmitting, to the one or more first computers, a list of names of the templates, in response to receipt of the search criteria; and

receiving, from the one or more first computers, a selected name of a template of the request.

5. The computer-implemented method of claim **1** further comprising, prior to receipt of the message that identifies the request:

preparing and transmitting one or more third screens to receive, from the one or more first computers, a mapping between a plurality of input parameters of the specific software code and a plurality of attributes of the request;

wherein the mapping is used in said executing.

6. The computer-implemented method of claim **1** further comprising:

preparing and transmitting one or more third screens to receive a plurality of selections identifying the names in the plurality of name value pairs selected from among a larger plurality of names of attributes output by the specific software code.

7. The computer-implemented method of claim **6** wherein:

at least two rule action pairs correspond to at least two includable regions identified in the set received for the request;

the computer-implemented method further comprises receiving from the one or more first computers, an additional sequence; and

at least two rules in said at least two rule action pairs are evaluated relative to one another in said additional sequence.

8. The computer-implemented method of claim **1** wherein the specific software code is comprised as a programmatic method in an object of an application module, and wherein the computer-implemented method comprises:

preparing and transmitting one or more third screens to receive from the one or more first computers, a first selection identifying said application module in a set of application modules deployed in the one or more second computers and a second selection identifying said object in said application module;

wherein the identifier of the specific software code identifies, in said object, said programmatic method.

9. The computer-implemented method of claim **1** wherein the message is hereinafter a first message, and the computer-implemented method further comprises:

responding to receipt of the first message identifying the request, by transmitting a header of the request comprising additional name value pairs;

wherein at least one value in the additional name value pairs identifies said at least one to-be-rendered region.

10. One or more non-transitory computer-readable storage media storing a plurality of instructions which, when executed by one or more processors, cause the one or more processors to generate requests to be displayed, the plurality of instructions comprising:

to execute in a setup operation, instructions to prepare and transmit one or more first screens to receive, from one or more first computers, a set of identifiers of one or more regions that are includable in a request for user input indicative of at least one of approval or disapproval;

to execute in the setup operation, instructions, executable for each includable region identified in the set, to receive from the one or more first computers a rule action pair corresponding to said each includable region, wherein the rule action pair comprises a rule and an identifier of a specific software code to be executed to render said each includable region when the rule is satisfied;

to execute a runtime operation, instructions, in response to receipt from a mobile device of a message that identifies the request, to evaluate in one or more second computers at least one rule in the rule action pair corresponding to at least one includable region identified in the set received for the request, to identify one or more regions to be rendered in displaying the request;

to execute in the runtime operation, instructions, for at least one to-be-rendered region identified by execution of the instructions to evaluate, to execute in the one or more second computers at least the specific software

code identified in the rule action pair corresponding to said at least one to-be-rendered region, to obtain from a relational database a plurality of first rows, each first row comprising a plurality of name value pairs; and

to execute in the runtime operation, instructions to prepare one or more second screens comprising at least content of the request, said at least content of the request comprising the plurality of name value pairs in a plurality of rows, each name value pair in the plurality of name value pairs being comprised in a single line of a second row in the plurality of second rows, each second row comprising a plurality of lines, the plurality of lines being sequenced relative to one another in a specific sequence received in the one or more first screens from the one or more first computers;

to execute in the runtime operation, instructions to transmit to the mobile device, said at least content of the request; and

to execute in the runtime operation, instructions to receive and store said user input in the relational database.

11. The one or more non-transitory computer-readable storage media of claim **10** wherein said at least one rule comprises an operator, an operand and a constant, and the plurality of instructions further comprising:

instructions to prepare and transmit one or more third screens to:

receive from the one or more first computers, a first selection identifying the operator in a set of operators;

receive from the one or more first computers, a second selection identifying the operand in a set of operands; and

receive from the one or more first computers, the constant;

wherein the operator, the operand and the constant are used in said evaluating.

12. The one or more non-transitory computer-readable storage media of claim **11** wherein the specific software code identified in the rule action pair is a first software code, and the one or more third screens are configured to:

receive from the one or more first computers, a third selection identifying for the rule a type of the operand in a set of types;

wherein the set of types comprises:

a first type identifying the operand as an attribute of the request; and

a second type identifying the operand as a result of executing a second software code.

13. The one or more non-transitory computer-readable storage media of claim **10** wherein the plurality of instructions comprise:

additional instructions executable prior to receipt of the set of identifiers, to:

prepare and transmit one or more third screens to receive, from the one or more first computers, search criteria to identify templates;

prepare and transmit, to the one or more first computers, a list of names of templates, in response to receipt of the search criteria; and

receive, from the one or more first computers, a selected name of a template of the request.

14. The one or more non-transitory computer-readable storage media of claim **10** wherein the plurality of instructions comprise:

additional instructions executable prior to receipt of the message that identifies the request, to:

prepare and transmit one or more third screens to receive, from the one or more first computers, a mapping between a plurality of input parameters of the specific software code and a plurality of attributes of the request;

wherein the mapping is used in said instructions to execute.

15. The one or more non-transitory computer-readable storage media of claim **10** wherein the plurality of instructions comprise:

instructions to prepare and transmit one or more third screens to receive a plurality of selections identifying the names in the plurality of name value pairs selected from among a larger plurality of names of attributes output by the specific software code.

16. The one or more non-transitory computer-readable storage media of claim **15** wherein:

at least two rule action pairs correspond to at least two includable regions identified in the set received for the request;

the plurality of instructions comprise instructions to receive from the one or more first computers, an additional sequence; and

at least two rules in said at least two rule action pairs are evaluated relative to one another in said additional sequence.

17. The one or more non-transitory computer-readable storage media of claim **10** wherein the specific software code is comprised as a programmatic method in an object of an application module, and the plurality of instructions comprise:

instructions to prepare and transmit one or more third screens to receive from the one or more first computers, a first selection identifying said application module in a set of application modules deployed in the one or more second computers and a second selection identifying said object in said application module;

wherein the identifier of the specific software code identifies, in said object, said programmatic method.

18. The one or more non-transitory computer-readable storage media of claim **10** wherein the message is hereinafter a first message, and the plurality of instructions comprise:

instructions to respond to receipt of the first message identifying the request, by transmitting a header of the request comprising additional name value pairs;

wherein at least one value in the additional name value pairs identifies said at least one to-be-rendered region.

19. The one or more non-transitory computer-readable storage media of claim **10** wherein:

the names in the plurality of name value pairs are implemented as columns in one or more tables of the relational database.

20. An apparatus comprising one or more processors coupled to one or more non-transitory computer-readable storage media, wherein the one or more non-transitory computer-readable storage media comprise a plurality of instructions executable by the one or more processors, the apparatus comprising:

to execute in a setup operation, means for preparing and transmitting one or more first screens to receive, from one or more first computers, a set of identifiers of one or more regions that are includable in a request for user input indicative of at least one of approval or disapproval;

to execute in the setup operation, means, configured for each includable region identified in the set, for receiving from the one or more first computers a rule action pair corresponding to said each includable region,

wherein the rule action pair comprises a rule and an identifier of a specific software code to be executed to render said each includable region when the rule is satisfied;

to execute in a runtime operation, means for responding to receipt from a mobile device of a message that identifies the request, by evaluating in one or more second computers at least one rule in the rule action pair corresponding to at least one includable region identified in the set received for the request, to identify one or more regions to be rendered in displaying the request;

to execute in the runtime operation, means, configured for at least one to-be-rendered region identified by the evaluating, for executing in the one or more second computers at least the specific software code identified in the rule action pair corresponding to said at least one to-be-rendered region, to obtain from a relational database a plurality of first rows, each first row comprising a plurality of name value pairs; and

to execute in the runtime operation, means for preparing one or more second screens comprising at least content of the request, said at least content of the request comprising the plurality of name value pairs in a plurality of rows, each name value pair in the plurality of name value pairs being comprised in a single line of a second row in the plurality of second rows, each second row comprising a plurality of lines, the plurality of lines being sequenced relative to one another in a specific sequence received in the one or more first screens from the one or more first computers;

to execute in the runtime operation, means for transmitting to the mobile device, said at least content of the request; and

to execute in the runtime operation, means for receiving and storing in the relational database, said user input on said request.

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